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A Catalog of the Blood-Sucking Fly Family Tabanidae (Horseflies and Deerflies) of the Nearctic Region North of Mexico

Cornelius B. Philip

Aldrich's once comprehensive catalog of North American Diptera (1905) is now badly outdated, and there is need for bringing the families of this important order of insects up to date. The present catalog of the Nearctic species of Tabanidae north of Mexico was prepared just before the outbreak of World War II, as part of an initial revision of the Brachycera Orthorrhapha under preparation by several students of respective families in that group. The war unfortunately interrupted plans for combined publication. In view of the increasing importance of parasitic arthropods in the welfare of man and animals, the author is confident that the new catalog will be both useful and timely, following as it does the impetus of attention given to another important family, the mosquitoes, through sanitary requirements for the military forces.

The publication of revisions of the two major subfamilies of the Nearctic Tabanidae, the Pangoniinae by Brennan in 1935 and the Tabaninae by Stone in 1938, greatly facilitated the present undertaking, though revision has progressed considerably even since these studies.

Based largely on the monographic work of Osten Sacken and Hine, the North American tabanids north of Mexico listed by Aldrich in 1905 included 171 recognizable species distributed among 8 genera. Since then generic concepts have been refined and specific compositions expanded, so that the present catalog includes 474 species in 27 genera, exclusive of subspecies and subgenera.

The geographic area covered here represents the known tabanid fauna north of the Mexican boundary, including only the Bermudas of the islands off the Atlantic Coast. For discussion of the species of the other Atlantic islands to the south, the recent paper by Bequaert (1940)[1] should be consulted. No records of any species invading Greenland are known to date.[2]

It has been the endeavor to include all references which give new or original information since Aldrich's catalog (1905), but only the monographic

1 Bequaert, J. 1940. The Tabanidae of the Antilles (Dipt.). Rev. de Ent. **11**(1-2): 253-369.

2 Henricksen, K. L. 1939. A revised index of the insects of Greenland. Medded. om Grønland, **119**(10): 1-112.

or important references previous to that year for the sake of brevity. Hine (1903) listed all the important early literature including previous catalogs by Osten Sacken and Kertész, which need not be repeated here.

Also for the sake of brevity, the customary abbreviations for Osten Sacken's "Western Diptera" and Walker's "Lists" have been employed. Since Macquart's descriptions semi-simultaneously appeared in two different series, the "Mémoirs" and "Dipt. exotique" series, the different paginations for the same species often leading to confusion on the part of subsequent bibliographers, both citations have been included. Marchand's valuable reprinting or summarization of all biological data and related figures published previous to 1920 has not been repeated as a reference under the respective species to which he added no original information.

It may be that further study will substantiate the opinion of some that elements now placed in the admittedly composite family Coenomyidae, really belong in the Tabanidae. On the other hand, the writer has omitted the genus *Bequaertomyia* Brennan 1935 for which in 1941 [3] he erected a tabanid tribe assigned to the subfamily Pelecorhynchinae. Omission from the present catalog follows the recent elevation by Mackerras and Fuller (1942)[4] of this primitive group of flies to family rank (Pelecorhynchidae) in which *Bequaertomyia* appears to form a distinctive Nearctic element probably warranting subfamily recognition.

In the main the supraspecific categories discussed by the writer in 1941 and 1942 have been followed in this catalog. *Agelanius* Rond. has been dropped because of lack of information on generic limits and distribution of this Neotropical genus. Since the development of the dorso-basal tooth on the third antennal segment in various species is unquestionably heterogenetic within the family in various parts of the world, the writer has decided again to take *Chlorotabanus* out of the tribe Dichelacerini. The general facies of this and the Neotropical *Cryptotylus*, including the lack of well-developed frontal callosities in the females and the lack of the antennal tooth in the majority of the species in this restricted group are so obviously different from the other dichelacerine genera as listed most recently by Fairchild, that to retain them in that tribe appears to me forced and unnecessarily artificial. Final stabilization of the supraspecific categories of certain minor elements of the Nearctic tabanid fauna will have to await clarification of the rich Mexican and Neotropical faunas.

In the meantime the following synoptic key is presented as an aid to supraspecific diagnosis, as well as to an understanding of the classification followed in the subsequent catalog of species:

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3 Philip, C. B. 1941. Comments on the supraspecific categories of Nearctic Tabanidae (Diptera). Canad. Ent., **73**:2-14; 1942. Further Notes on Nearctic Tabanidae (Diptera). Proc. N. Eng. Zool. Club, **21**:55-58 (see also Fairchild, 1942, Ann. Ent. Soc. Amer., **35**:465-468).

4 Mackerras, I. M. and Fuller, M. E. 1942. The genus *Pelecorhynchus* (Diptera, Tabanoidea). Proc. Linn. Soc. N. S. Wales, **67**:9-76.

SYNOPTIC KEY TO THE SUPRASPECIFIC CATEGORIES OF THE NEARCTIC TABANIDAE

A. Hind tibiae with two apical, usually strong spurs (weakest in the rare *Merycomyia*); subepaulets bare, uninflated ....I Subfamily Pangoniinae Loew. (p. 262)

B. Antennae 9-10 segmented (flagellum with at least 7 annuli, the basal one not greatly differentiated) .....A. Tribe Pangoniini End.

C. Eyes (♀) with upper angles sharply acute; wings with a wide, sharply marked, irregular brown pattern .....1. *Goniops* Aldrich (p. 264)

CC. Eyes above at most rectangulate; wings hyaline or diffusely tinted.

D. Proboscis hardly half the height of the head; palpi usually shorter than the antennae and swollen basally.

E. Eyes bare .....2. *Apatolestes* Will. (p. 262)

EE. Eyes and body abundantly pilose .....3. *Brennania* Philip (p. 263)

DD. Proboscis about equal to height of head; palpi subequal to length of the antennae, half or less that of the proboscis, not swollen basally.

E. Cell R_5 closed and petiolate .....4. *Esenbeckia* Rond. (p. 263)

EE. Cell R_5 open at wing margin.

F. Eyes hairy (short in ♀); base of vein R_4 with short spur .....5. *Pilimas* Brennan (p. 264)

FF. Eyes bare; R_4 often without spur .....6. *Stonemyia* Brennan (p. 265)

BB. Antennae with not over 7 segments (flagellum with at most 5 divisions, the basal one considerably elongated); proboscis seldom exceeding height of head.

C. Flagellum with 5 divisions (4 annuli); usually slender, often pictured-winged flies .....B. Tribe Chrysopini End.

D. Eyes in life (or relaxed) "freckled" with small rounded spots; pedicel (second segment) of antenna either about half the length of the scape or distinctly longer than the flagellum; wings hyaline or with isolated clouds on cross-veins.

E. Flagellum of antenna much shorter than either of the basal segments and shaped like a bowling pin with a bent neck, pedicel nearly as long as scape .....1. *Assipala* Philip (p. 267)

EE. Flagellum at least longer than pedicel, the latter only about half as long as scape.

F. Flagellum longer than 2 basal segments combined .....2. *Silvius* Meig. (p. 266)

FF. Flagellum about three-fourths as long as scape alone .....2a. *Silvius* subg. *Zeuximyia* Philip (p. 267)

DD. Eyes in life (or relaxed) with large angular spots; scape and pedicel usually subequal, the flagellum as long or longer than either; wings usually with irregular, extensive dark pictures.

E. Abdomen globose, much wider than thorax, wings evenly fumose, a spur at base of vein R_4 .....3. *Neochrysops* Walton (p. 283)

EE. Abdomen slender; wings mostly with irregular dark patterns, no spurs (except adventitiously) .....4. *Chrysops* Meig. (p. 268)

CC. Third antennal segment with 3 divisions (2 annuli); rare, robust, *Tabanus*-like species .....C. Tribe Merycomyini Philip

D. Only one genus .....1. *Merycomyia* Hine (p. 283)

AA. Hind tibiae without apical spurs .....II Subfamily Tabaninae Loew

B. Subepaulets (basicostae) bare and flat (in Nearctic spp.).

C. Labellae sclerotized, smooth and shining.

D. Bodies compact, uniformly dull greenish or yellow; females without frontal callosities, otherwise head, wing and leg characters not unusual .....A. Tribe Chlorotabanini Philip

E. Only one Nearctic genus ..... 1. *Chlorotabanus* Lutz (p. 286)

DD. Bodies more slender, predominantly black; subcallus, antennal scape and tibiae swollen; vein R_4 curved abruptly forward apically .....B. Tribe Bolbodimyini Philip

E. Only one genus .....1. *Bolbodimyia* Bigot (p. 284)

CC. Labellae fleshy, shrunken and distorted when dry .....C. Tribe Diachlorini End.

D. Fore-tibiae swollen, more thickened than the respective femora or other tibiae; wing with a fumose apical spot and no spur-vein on base of R_4 .....1. *Diachlorus* O.S. (p. 284)

DD. Fore-tibiae normal; wing hyaline or the cross-veins clouded, and spur present on base of R_4.

E. Bodies pruinose without distinct pattern (in Nearctic spp.); females with very wide fronts and no ocelligerous tubercles, males with occipital tubercles suppressed .....2. *Aegialomyia* Philip (p. 285)

EE. Bodies bicolored or with definite pattern; females with normal fronts and distinct ocelligerous tubercles, males with prominent tubercles in the occipital notch .....3. *Stenotabanus* Lutz (p. 285)

BB. Subepaulets with hairs like those on the costal vein; often inflated.

C. Flagellum of antennae with 4 divisions (3 annuli); scape considerably longer than thick; eyes in life (or relaxed) and wings with irregular bands and spots .....D. Tribe Chrysozonini Philip

D. Only one Nearctic genus .....1. *Chrysozona* Meig. (p. 287)

CC. Flagellum usually with 5 divisions (rarely fewer by apical fusion of annuli and then wings hyaline); scape scarcely longer than thick; eyes in life banded or unicolorous .....E. Tribe Tabanini End.

D. Plate of third antenna segment with a hook-like, dorso-basal extension; eyes sparsely hairy.

E. Subcallus above antennae with erect, black hairs laterally .....1. *Agkistrocerus* Philip (p. 289)

EE. Subcallus pollinose, no hair .....2. *Hamatabanus* Philip (p. 289)

DD. Plate rarely with dorso-basal, forward directed tooth, and if so, eyes bare.

E. Flagellum modified with 2 to 3 terminal annuli, the articulations more or less fused and indistinct; small flies, 11 mm. and under.

F. Very small flies, length under 9.5 or rarely 10 mm.; frontal callosity (♀) missing or rudimentary; eyes ostensibly bare, unbanded in life .....3. *Microtabanus* Fchld. (p. 287)

FF. Length 9.5 to 11 mm.; frontal callosity distinct; eyes bare or very sparsely pilose, banded in life (or relaxed) .....4. *Glaucops* Szil. (p. 287)

EE. Flagellum normal, 4 distinct annuli; small to large flies.

F. Vertex (♀) with a distinct, denuded ocelligerous tubercle, or (♂) with an elevated, anteriorly shining tubercle (in doubtful cases eyes are densely pilose).

G. Eyes ostensibly bare; front (♀) narrow, the callosity long and linear; upper eye facets (♂) strongly differentiated and enlarged; scutellum pallid .....5. *Leucotabanus* Lutz (p. 290)

GG. Eyes usually distinctly pilose; front (♀) variable, but the basal callosity correspondingly broad; eye facets (♂) relatively undifferentiated; scutellum usually dark....6. *Hybomitra* End. (p. 291)

FF. Vertex without such tubercles, if raised in ♂ then completely pollinose (eyes bare, or sparsely but seldom densely [certain males] pilose).

G. Eyes yellow or brown, distinctly pilose, particularly in males;

front (♀) without callosities, or they are reduced to small isolated bare spots (a single diagonal, dark band on eyes, often showing even in dried condition) .....7. *Atylotus* O. S. (p. 287)

GG. Eyes blackish when dried (certain males only lower area of small facets), bare or if sparsely hairy, with more than one purple band in life and the abdomen may have a uniform, pale, mid-dorsal stripe; front (♀) with a broad basal callosity.

H. Antennae including annuli, and palpi with unusually erect hairs, palpi blunt and stout, the proboscis relatively, quite small; "post-ocular rim" (between eye margins and occipital hairs) unusually wide .....8. *Anacimas* End. (p. 289)

HH. Not with this combination of characters, annular hair very inconspicuous.

I. Body and wings entirely deep brown to black (abdomen may have pale lateral vestiture); frontal and facial callosities unusually protuberant and shining (eyes bare, in life with the upper of 4 purple bands strongly decurved and widened outwardly as in *Heptatoma*) .....9. *Whitneyomyia* Beq. (p. 290)

II. Body and wings varicolored (when entirely black, over 15 mm. in length); eyes bare or sparsely hairy .....10. *Tabanus* Linn. (p. 300)

Symbols in the text include an asterisk (*) before previously unpublished State or Provincial distribution records, and appropriate parenthetical letters where the associated reference discusses or provides the following: "k" for "key", "e" for "egg", "l" for "larva", "p" for "pupa", and "f" for "figure", or such combinations as "kp" or "fp". Sex signs are provided both for the type(s) and the first description of the opposite sex. In some instances where the allotype is included in the original description with the holotype, it was necessary to parenthesize the sex sign of the former at the end of the original reference preceding that of the holotype. In other instances, the first description of the opposite sex occurred as a synonym species and is so indicated in the text. References containing systematic changes or new taxonomic arrangements are indicated by "(synonymy)."

Customary abbreviations for museums where types are located are as follows: "U.S.N.M." for "U. S. National Museum (Washington, D. C.)," "M.C.Z." for "Museum of Comparative Zoology (Cambridge, Mass.)," "B.S.N.H." for "Boston Society of Natural History", "A.M.N.H." for "American Museum of Natural History (New York City)," "C.A.S." for "California Academy of Sciences," "B.M.N.H." for "British Museum of Natural History," "C.N.C." for "Canadian National Collection (Ottawa)," or respective state institutions as "Kan. U." for "University of Kansas," and private collections as "Coll. Philip" (Hamilton, Montana).

Considerable pains were taken to verify existence of types in the various European institutions before the outbreak of hostilities, but their survival under the exigencies of war will require a considerable time for rechecking. It is known that the British Museum types and Bellardi's types at Turin Museum were protected from damage by removal for safe storage. It is to be hoped that other historic collections were similarly protected from war damage.

Pre-war comparisons of forwarded specimens were made for the author by respective curators in many of these foreign institutions, while both the Berlin and Vienna Museums generously loaned certain problematic types. The nature of this compilation does not permit space for the specific naming of all these and the many other persons at American institutions who have lent material or have permitted examination of specimens in their charge, as well as of private collections. The writer has at various times had the privilege of studying types and pertinent material in the key tabanid collections of the U. S. National Museum, Canadian National Museum, American Museum of Natural History, Museum of Comparative Zoology, Philadelphia Academy of Natural Sciences, Ohio State, Kansas, and Minnesota Universities, and the California Academy of Sciences. To all persons providing these and countless other courtesies over a period of years, the writer is deeply indebted.

Tabanidae

Osten Sacken, 1875-6, Mem. Boston Soc. Nat. Hist., **2**(4): 365-397, 421-479, 555-560 (k). Williston, 1886, Trans. Kans. Acad. Sci., **10**:129-142 (k). Hart, 1896, Bull. Ill. Lab. Nat. Hist., **4**:220-247 (l, p. k). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, 63 pp. (k, f) (catalog Nearctic species); 1904, Ohio Nat., **5**:217-248 (k, western spp.). Aldrich, 1905, Smithsonian Miscell. Collec. **46** (Bull. No. 1444), pp. 192-209. Malloch, 1917, Bull. Ill. Lab. Nat. Hist., **12**:355-361 (l, p, k, f). Marchand, 1920, Monog. Rock. Inst. Med. Res., No. 13, 203 pp., 15 pl. (resume all biol. inform. and illus.). Surcouf, 1921, Gen. Ins., Fasc. 175, 205 pp., 5 pl. (world catalog). Enderlein, 1922, Mitt. Zool. Mus. Berlin, **10**(2):333-351; 1925, ibid., **11**(2):255-409 (k, f). Bequaert, 1924, Psyche, **31**:24-40 (critique prev. 2 authors). Kröber, 1934, Rev. Ent., **4**:222-276; 291-333 (catalog Neotrop. spp., useful suppl. for many Nearc. genera). Philip, 1941, Canad. Ent., **73**:2-14 (k, Nearc. genera); 1942, Proc. N. Eng. Zool. Club, **21**:55-58.

Subfamily PANGONIINAE Loew, 1860,

Dipterenfauna Südafrika's, p .31. Brennan, 1935, U. Kans. Sci. Bull., **22**:249-401 (k, f). Philip, 1941, Canad. Ent., **73**:3 (k).

Section ORTHACANTHAE Lutz, 1909, Zool. Jahrb. Sup. **10**:624; 1911, Mem. Inst. Oswaldo Cruz, **3**:295. Enderlein, 1922, Mitt. Zool Mus. Berlin, **10**:335; 1925, **11**:261 (k). Kröber, 1932, Rev. Ent., **2**:193 (k). All partim of Section.

Tribe PANGONIINI Enderlein, 1922,

Mitt. Zool. Mus. Berlin, **10**:338; 1925, **11**:279 (k). Kröber, 1932, Rev. Ent., **2**:195 (k); 1934, **4**:235 (cat. Neotr. spp.). Philip, 1941, Canad. Ent., **73**:4 (k).

APATOLESTES Williston, 1885,

Ent. Amer., **1**:12. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 31 (k); 1904, Ohio Nat., **5**:218 (k), 230. Brennan, 1935, U. Kans. Sci. Bull., **22**:370 (k). Philip, 1941, Canad. Ent., **73**:9 (k); 1941, Bull. Brooklyn Ent. Soc., **36**:187 (k). Genotype, *Apatolestes comastes* Williston, orig. monotype.

1. *aitkeni* Philip, 1941, Bull. Brooklyn Ent. Soc., **36**:191 (♂). Type, ♀, Baboquivari Mts., Ariz.; C.A.S. No. 5148.

2. *albipilosus* Brennan, 1935, U. Kans. Sci. Bull., **22**:371. Type, ♀, Lemon Cove,

Calif.; U. Kans. Philip, 1941, Bull. Brooklyn Ent. Soc., **36**:197. Male unknown. Calif.

3. *ater* Brennan, 1935, U. Kans. Sci. Bull., **22**:371 (♂). Type, ♀, San Diego, Calif.; U. Kans. Philip, 1941, Bull. Brooklyn Ent. Soc., **36**:189. Calif.

4. *colei* Philip, 1941, Bull. Brooklyn Ent. Soc., **36**:192 (♂). Type, ♀, La Quinta, Calif.; Coll. Philip.

5. *comastes* Williston, 1885, Ent. Amer., **1**:12. Cotypes, 2♀♀, California; U. Kans. Townsend, 1895, Proc. Calif. Acad. Sci., **4**:596. Hine, 1904, Ohio Nat., **5**:230. Cole, 1923, Proc. Calif. Acad. Sci., **12**:458. Brennan, 1935, U. Kans. Sci. Bull., **22**:372 (f). Philip, 1941, Bull. Brooklyn Ent. Soc., **36**:188. Male unknown. Calif.

5a. subsp. *willistoni* Brennan, 1935, U. Kans. Sci. Bull., **22**:373. Type, ♀, San Diego County, Calif.; U. Kans. Philip, 1941, Pan-Pac. Ent., **36**:189 (♂). Ariz., Calif., *Ore., Mont., *B.C.

6. *hinei* Brennan, 1935, U. Kans. Sci. Bull., **22**:374 (♂). Type, ♀, San Jacinto Mts., Calif.; U. Kans. Philip, 1941, Pan-Pac. Ent., **36**:189.

7. *parkeri* Philip, 1941, Pan-Pac. Ent., **36**:193 (♀). Type, ♂, Ehrenberg, Ariz.; Coll. Philip.

8. *similis* Brennan, 1935, U. Kans. Sci Bull., **22**:374 (♂). Type, ♀, Los Angeles Co., Calif.; U.S.N.M. No. 54065. Philip, 1941, Pan-Pac. Ent., **36**:195. Calif., *Ariz., Utah.

?*Tabanus villosulus* Bigot, 1892, Mem. Soc. Zool. Fr., **5**:684. Cotypes, 2♂♂, Calif.; B.M.N.H. Philip, 1941, Bull. Brooklyn Ent. Soc., **36**:196 (synonymy).

villosulus (Bigot), equals (?) *similis*.

BRENNANIA Philip, 1941,

Bull. Brooklyn Ent. Soc., **36**:196 (new name).

Syn. *Comops* Brennan 1935, U. Kans. Sci. Bull., **22**:375 (subgenus, k). Genotype, *Pangonia hera* Osten Sacken, monotype.

1. *hera* (Osten Sacken), 1877, West. Dipt., p. 214 (*Pangonia*). Type, ♀, San Francisco, Calif., M.C.Z. No. 900. Parker, 1925, Proc. Ent. Soc. Wash., **27**:195. Brennan, 1935, U. Kans. Sci. Bull., **22**:375. Philip, 1941, Bull. Brooklyn Ent. Soc., **36**:196 (synonymy). Calif.

Pangonia hera. Hine, 1904, Ohio Nat., **5**:227.
Diatomineura hera. Surcouf, 1921, Gen. Ins., Fasc. 175, p. 130.

ESENBECKIA Rondani, 1863,

Arch. Zool. Modena, **3**:83. Lutz, 1909, Zool. Jahrb. Suppl. **10**:661. Enderlein, 1925, Mitt. Zool. Mus. Berlin, **11**:287. Kröber, 1931, Zool. Anz., **94**:245; 1932, Rev. Ent., **2**:82. Borgmeier, 1933, Rev. Ent., **3**:292. Brennan, 1935, U. Kans. Sci. Bull., **22**:358 (k). Philip, 1941, Canad. Ent. **73**:4, 9 (k); 1941, Proc. Ent. Soc. Wash., **43**:116. Genotype, *Silvius vulpes* Wiedemann, orig. desig.

Syn. *Esenbekia* Rondani, 1863 (lapsus) (l.c.).

Syn. *Dyspangonia* Lutz, 1905, Rev. Soc. Sci. San Paulo **1**(1): 22, 27; 1907, Centralbl. Bakt. Abt. 1, **44**:142. Bequaert, 1924, Psyche, **31**:28. Genotype, *Pangonia fuscipennis* Wiedemann, design. by Bequaert, 1924.

Syn. *Esenbackia* Surcouf, 1909, Bull. Mus. Nat. Paris **15**:257 (lapsus).

Syn. *Eisenbeckia* Marchand, 1918, Trans. Amer. Ent. Soc., **44**:177 (lapsus).

1. *delta* (Hine), 1920, Ohio Jour. Sci., **20**:313 (*Pangonia*). Type, ♂, Hauchuca Mountains, Ariz.; Ohio S. U. Hine, 1925, Occ. Pap. Mus. Zool. Univ. Mich. No. 162, p. 6 (synonymy). Brennan, 1935, U. Kans. Sci. Bull., **22**:358. Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:196 (♀); 1941, Proc. Ent. Soc. Wash., **43**:116. Ariz., Tex.

Pangonia saussurei Hine, 1904, Ohio Nat., **5**:228. Not Bellardi, 1859, Saggio ditter. Mess., **1**:49.

incisa Wiedemann, equals *incisuralis*.

2. *incisuralis* (Say), 1823, Jour. Acad. Nat. Sci. Philad., **3**:31 (*Pangonia*). Cotypes, ♂, ♀, Arkansas; lost. Williston, 1887, Trans. Kans. Acad Sci., **10**:130 (synonymy). Brennan, 1935, U. Kans. Sci. Bull., **22**:359, 378 (f). Philip, 1941, Proc. Ent. Soc. Wash., **43**:116 (synonymy). Ark., Kans., Okla., Tex., N.M., Ariz.

Pangonia incisa Wiedemann, 1828, Auss. zweifl. Ins., **1**:90. Type, ♀, Arkansas; Vienna Nat. Mus.? Hine, 1904, Ohio Nat., **5**:228.

Ricardoa (?) *incisa*. Kröber, 1934, Rev. Ent., **4**:244.

Ricardoa latiflagrum Enderlein, 1925, Mitt. Zool. Mus. Berlin, **11**:291. Type, ♀, Dallas, Texas; Berlin Mus. No. 7457.

latiflagrum (Enderdein), equals *incisuralis*.

GONIOPS Aldrich, 1892.

Psyche, **6**:236-237; 1900, Ent. News, **11**:531. Hine, 1900, Ent. News, **11**:392 (synonymy); 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 46 (k). Malloch, 1917, Bull. Ill. Lab. Nat. Hist., **12**:356 (lk, pk). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:191 (k). Stone, 1930, Ann. Ent. Soc. Wash., **23**:272, 293 (e, l). Schwardt and Hall, 1930, Ark. Exp. Sta., Bull. No. 256, p. 10 (k). Brennan, 1935, U. Kans. Sci. Bull., **22**:368 (k). Philip, 1941, Proc. Ent. Soc. Wash., **43**:116; 1941, Canad. Ent. **73**:9 (k). Genotype, *Pangonia chrysocoma* Osten Sacken, monotype.

Syn. *Conisops* Kertesz, 1900, Catal. Tabanid., p. 25 (lapsus).

1. *chrysocoma* (Osten Sacken), 1875, Mem. Boston Soc. Nat. Hist., **2**:368 (*Pangonia*). Cotypes, ♂, ♀, (lectotype, ♀, N.Y., Fairchild, 1938); M.C.Z. No. 4005. Hine, 1900, Ent. News, **11**:362 (synonymy); Ohio Nat., **2**:168; Ohio State Acad. Sci. Spec. Pap. No. 5, p. 46. Malloch, 1903, Bull. Ill. Lab. Nat. Hist., **12**:356. Walton, 1908, Ent. News, **19**:464 (ef, lf). McAtee, 1911, Proc. Ent. Soc. Wash., **13**:21-29 (ef, lf, pf, f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:191. Stone, 1930, Ann. Ent. Soc. Amer., **23**:293. Schward, 1934, Jour. Kans. Ent. Soc., **7**:73 (e, l, p); 1936, Ark. Exp. Sta. Bull. No. 332, p. 11 (ef, lf, pf, f). Brennan, 1935, U. Kans. Sci. Bull., **22**: 372 (f). N.Y., N.J., Pa., Del., Md., D.C., Va., W.Va., S.C., Ohio, *Ky., Ark.

Goniops hippoboscoides Aldrich, 1892, Psyche, **6**:236 (f). Types, 2♀♀, Jeanette, Penn.; U.S.N.M. No. 53627.

hippoboscoides (Aldrich), equals *chrysocoma*.

PILIMAS Brennan, 1941.

Proc. Ent. Soc. Wash., **43**:130 (note establishing genotype); 1925, U. Kans. Sci. Bull., **22**:361 (subgenus nomen nudum, k), 366. Philip, 1941, Canad. Ent., **73**:4, 9 (k). Genotype, *Diatomineura californica* Bigot, by desig. Brennan, 1941.

1. *beameri* Philip, 1942, Proc. N. Eng. Zool. Club, **21**:61. Type, ♀, Colton, Calif.; M.C.Z. No. 25919.

2. *californica* (Bigot), 1892, Mem. Soc. Zool. Fr., **5**:618 (*Diatomineura*). Type, ♂, California; B.M.N.H. Brennan, 1935, U. Kans. Sci. Bull., **22**:366 (f, synonymy). Philip, 1941, Proc. Ent. Soc. Wash., **43**:114 (synonymy). Female, see *Pangonia dives* below. B.C., Mont., Wash., Ore., Ida., Utah, Calif.

Diatomineura californica Ricardo, 1900, Ann. Mag. Nat. Hist., Ser. 7, **5**:169.

Pangonia dives Williston, 1887, Trans. Kans. Acad. Sci., **10**:130. Cotypes, ♂, 4♀♀, Calif.; U. Kans. Hine, 1904, Ohio Nat., **5**:227. Not Macquart, 1857, Dipt. exot. nouv. peu connus, Sup. I, 25 (f).

Diatomineura dives. Surcouf, 1821, Gen. Ins., Fasc. 175, p. 131. Ricardo, 1900, Ann. Mag. Nat. Hist., Ser. 7, **5**:169.

Silvius jonesi Cresson, 1919, Proc. Acad. Nat. Sci. Philad., p. 175 (♀). Type, ♂, Keddie, Plumas Co., Calif.; A.N.S.P. No. 61977.

Stonemyia (*Pilimas*) *jonesi*. Brennan, 1935, U. Kans. Sci. Bull., **22**:367.

STONEMYIA Brennan, 1935,

U. Kans. Sci. Bull., **22**:360 (k). Philip, 1941, Canad. Ent., **73**:4, 9 (k); 1941, Proc. Ent. Soc. Wash., **43**:113. Genotype, *Pangonia tranquilla* Osten Sacken, orig. designation.

1. *abaureus* Philip, 1941, Proc. Ent. Soc. Wash., **43**:114 (♀). Type, ♂, Patrick Creek, Calif.; Coll. Philip. Calif., Wyo.?

Pangonia ruficornis of authors, not Bigot, 1892, Mem. Soc. Zool. Fr., **5**:615.

Stonemyia ruficornis Brennan, 1935, U. Kans. Sci. Bull., **22**:364. Not Bigot, 1892, Mem. Soc. Zool Fr., **5**:228.

albomacula Stone, equals *velutina*.

2. *pigra* (Osten Sacken), 1875, Mem. Boston Soc. Nat. Hist., **2**:367 (*Pangonia*). Cotypes, 2♀♀, ♂ (lectotype, ♀, Ky., Fairchild, 1938); M.C.Z. No. 4003. Brennan, 1935, U. Kans. Sci. Bull., **22**:362. Philip, 1941, Proc. Ent. Soc. Wash., **43**:115. N.J., N.Y., *Pa., Del., Md., D.C., Va., N.C., Ky.

Pangonia pigra. McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:191. Ricardo, 1900, Ann. Mag. Nat. Hist., Ser. 7, **5**:170.

Buplex pigra. Leonard, 1926, Cornell U. Agr. Expt. Sta. Mem. 101, p. 754.

3. *rasa* (Loew), 1869, Dipt. Amer. Sept. Ind., II, p. 119 (pt. VIII, no. 7) (*Pangonia*). Types, 2♀♀, North. Wis.; Berlin U. Zool. Mus. Brennan, 1935, U. Kans. Sci. Bull., **22**:363 (synonymy). Female, see *Pangonia rasa* below. Que., Me., Mass., N.H., Conn., *R.I., N.Y., N.J., Md., Pa., D.C., Va., Ohio, Ill., Ind., Mich., Wis.

Pangonia rasa. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:366 (♀). Williston, 1887, Trans. Kans. Acad. Sci., **10**:130. Ricardo, 1900, Ann. Mag. Nat. Hist., Ser. 7, **5**:170. Hine, 1901, Ohio Nat., **2**:169; Ohio State Acad. Sci. Spe. Pap. No. 5, p. 45. McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:191.

Buplex rasa. Bequaert, 1924, Psyche, **31**:33. Leonard, 1926, Cornell U. Agr. Exp. Sta. Mem. 101, p. 754. Philip, 1931, Minn. Agr. Exp, Sta. Tech. Bull. No. 80, p. 95.

? *Silvius isabellinus* Wiedemann, 1828, Auss. zweifl. Ins., **1**:112. Type, ♀, North America; Berlin U. Zool. Mus. Osten Sacken, 1878, Smithsn. Misc. Collect., **270**:52, 225 (synonymy). Walker, 1854, List. V (sup. 1), p. 274.

4. *ruficornis* (Bigot), 1892, Mem. Soc. Zool. Fr. **5**:615 (*Corizoneura*). Cotypes, 2♂♂, California (labelled with MS names, C. "*ruficosta*"); B.M.N.H. Philip,

1941, Proc. Ent. Soc. Wash., **43**:114 (♀). Calif.

Pangonia ruficornis. Hine, 1904, Ohio Nat., **5**:228.

Corizoneura ruficornis. Ricardo, 1900, Ann. Mag. Nat. Hist., Ser. 7, **5**:169. Surcouf, 1921, Gen. Ins., Fasc. 175, 134.

5. *tranquilla* (Osten Sacken), 1875, Mem. Boston Soc. Nat. Hist., **2**:367 (*Pangonia*). Cotypes, ♂, 2♀♀ (lectotype, ♀, White Mts., N.H., desig. Fairchild, 1938); M.C.Z., No. 4004. Brennan, 1935, U. Kans. Sci. Bull., **22**:365 (f). Philip, 1942, Proc. N. Eng. Zool. Club, **21**:60 (synonymy). Chagnon and Fournier, 1943, Nat. Canadien, **70**:72. Que., Me., N.H., Vt., Conn., N.Y., Pa., *N.C., Mich., Wis.

Pangonia tranquilla. Williston, 1887, Trans. Kans. Acad. Sci., **10**:130. Ricardo, 1900, Ann. Mag. Nat. Hist., Ser. 7, **5**:169. Andrews, 1918, Occ. Pap. Univ. Mich. No. 53, p. 3.

Corizoneura tranquilla. Surcouf, 1921, Gen. Ins., Fasc. 175, p. 134.

Buplex tranquilla. Bequaert, 1924, Psyche, **31**:33. Leonard, 1926, Cornell U. Agr. Expt. Sta. Mem. 101, p. 754. Johnson, 1927, Inst. Mt. Desert Reg., p. 179.

5a. subsp. *fera* (Williston), 1887, Trans. Kans. Acad. Sci., **10**:130 (*Pangonia*). Type, ♂, Mt. Hood, Ore.; U. Kan. B.C., Wash., Ore., Calif., Ida., Me.

Pangonia fera. Hine, 1904, Ohio Nat., **5**:227 (♀).

Corizoneura fera. Ricardo, 1900, Ann. Mag. Nat. Hist., Ser. 7, **5**:169. Surcouf, 1921, Gen. Ins., Fasc. 175, p. 134.

Buplex fera. Bequaert, 1924, Psyche, **31**:33.

Stonemyia fera. Brennan, 1935, U. Kans. Sci. Bull., **22**:361.

6. *velutina* (Bigot), 1892, Mem. Soc. Zool. Fr., **5**:615 (*Corizoneura*). Type, ♀, California; B.M.N.H. Philip, 1941, Bull. Brooklyn Ent. Soc., **36**:199 (synonymy). Calif.

Stonemyia albomacula Stone, 1940, Proc. Ent. Soc. Wash., **42**:60 (f, ♂). Type, ♀, Bass Lake, Madera Co., Calif.; U.S.N.M. No. 53931.

Corizoneura velutina. Ricardo, 1900, Ann. Mag. Nat. Hist., Ser. 7, **8**:169.

Tribe, CHRYSOPINI Enderlein, 1922,

Mitt. Zool. Mus. Berlin, **10**:341 (k); 1925, **11**:305 (k). Kröber, 1932, Rev. Ent., **2**:194 (k); 1934, **4**:223 (Cat. Neotr.). Philip, 1941, Canad. Ent., **73**:4 (k, more inclusive).

SILVIUS Meigen, 1820,

Syst. Beschreib. Europ. zweifl. Ins., **2**:27. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:365 (k). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 31 (k); 1904, Ohio Nat., **5**:224 (k). Philip, 1931, Minn. Expt. Sta. Tech. Bull. No. 80, p. 79 (k). Brennan, 1935, U. Kans. Sci. Bull., **22**:351 (k). Pechuman, 1938, Canad. Ent. **70**:165 (synonymy, review Nearctic species, k, f). Philip, 1941, Canad. Ent., **73**:4, 9; 1941, Bull. Brooklyn Ent. Soc., **36**:185 (synonymy). Genotype, *Tabanus vituli* Fabricius, orig. monotype.

1. *gigantulus* (Loew), 1872, Dipt. Amer. Sept. ind., II, p. 233 (p. 10, No. 12) (*Chrysops*). Type, ♀, Calif., M.C.Z. No. 4024. Osten Sacken, 1877, West Dipt., p. 215 (synonymy). Hine, 1904, Ohio Nat., **5**:229 (♂). Wehr, 1924, Nebr. Univ. Studies, **22**:110. Brennan, 1935, U. Kans. Sci. Bull., **22**:352 (f). Rowe and Knowlton, 1936, Ohio Jour. Sci., **36**:254. Pechuman, 1938, Canad. Ent., **70**:170. B.C., Wash., Ore., Ida., Mont., *Wyo., Colo., N.M., Nebr., Calif.

Silvius trifolium Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:395. Co-

types. 2♀♀ (lectotype, ♀, Vancouver Island, Fairchild, 1938, Proc. New Eng. Zool. Club, **17**:34); M.C.Z. No. 4001.

isabellinus Wiedeman, equals (?) *Stonemyia rasa.*
jonesi Cresson, equals *Stonemyia californica.*
laticallus Brennan, equals *notatus.*

2. *microcephalus* Wehr, 1924, Nebr. Univ. Studies, **22**:109. Type, ♀, Ute Creek, Costilla Co., Colo.; Neb. U. Brennan, 1935, U. Kans. Sci. Bull., **22**:354 (♂). Pechuman, 1938, Canad. Ent., **70**:170. Colo.

3. *notatus* (Bigot) 1892, Mem. Soc. Zool. Fr. **5**:623 (*Diachlorus*). Type, ♀, California; B.M.N.H. Philip, 1941, Bull. Brooklyn Ent. Soc., **36**:186. (synonymy). Male, see *laticallus* below. Calif., Ore., Wash.

Silvius laticallus Brennan, 1935, U. Kans. Sci. Bull., **22**:353 (f, ♂). Type, ♀, Hermiston, Ore.; Kans. U. Pechuman, 1938, Canad. Ent., **70**:170.

4. *pollinosus* Williston, 1880, Trans. Conn. Acad. Arts Sci., **4**:244. Cotypes, unstated no. ♀♀, Western Kansas; Kans. U. (one specimen remaining). Williston, 1887, Trans. Kans. Acad. Sci., **10**:131. Snow, 1903, Kans. Univ. Sci. Bull., **2**:213. Hine, 1904, Ohio Nat., **5**:229 (♂). Wehr, 1924, Nebr. Univ. Studies, **22**:110. Brennan, 1935, U. Kans. Sci. Bull., **22**:355 (f). Rowe and Knowlton, 1936, Ohio Jour. Sci., **36**:255. Pechuman, 1938, Canad. Ent., **70**: 170, 171. S.D., Neb., Kans., Okla., Colo., *Wyo., Utah?, N.M., Ariz.

5. *quadrivittatus* (Say), 1823, Jour. Acad. Nat. Sci. Philad., **3**:33 (*Chrysops*). Cotypes, unstated no. ♀♀, near the Rocky Mountains; lost. Williston, 1887, Trans. Kans. Acad. Sci., **10**:131 (synonymy); 1892, Trans. Kans. Acad. Sci., **13**:134 (♂). Hine, 1904, Ohio Nat., **5**:229. Wehr, 1924, Nebr. Univ. Studies, **22**:110. Philip, 1931, Minn. Expt. Sta. Tech. Bull. No. 80, p. 95. Brennan, 1935, U. Kans. Sci. Bull., **22**:356 (f). Rowe and Knowlton, 1936, Ohio Jour. Sci., **36**:254 (f). Pechuman, 1938, Canad. Ent., **70**:169, 170. Minn.?, S.D., Neb., Kans., Okla., Texas., N.M., Ariz., Colo., Wyo., Mont., *Ida., Utah, *Nev., Calif.

5a. subsp. *texanus* Pechuman, 1938, Canad. Ent., **70**:166 (synonymy, f, ♂). Type, ♀, College Station Texas; Coll. Pechuman. Texas, *Okla.

Silvius sayi Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:196 (♂ misidentification). Not Brennan, 1938, U. Kans. Sci. Bull., **22**:357.

6. *sayi* Brennan, 1935, U. Kans. Sci. Bull., **22**:357 (f). Type, ♀, Texas; U.S.N.M. No. 50504. Pechuman, 1938, Canad. Ent., **70**:169, 170. Male unknown. Tex.

trifolium Osten Sacken, equals *gigantulus.*

Subgenus ZEUXIMYIA Philip, 1941.

Bull. Brooklyn Ent. Soc., **36**:186. Genotype, *Silvius philipi* Pechuman, monotype.

7. *philipi* Pechuman, 1938, Canad. Ent., **70**:165 (f). Type, ♀, near Lebanon, Ore.; Coll. Pechuman. Male unknown. Ore.

ASSIPALA Philip, 1941.

Canad. Ent., **73**:4, 9, (k); 1941, Rev. Ent., **12**:471 (k); 1942 (antedated in print as "1940"), Rev. Chilena Hist. Nat., **44**:190-194. Genotype, *Chrysops tanycerus* Osten Sacken, orig. designation.

1. *ceras* (Townsend), 1897, Psyche, **8**:38 (*Chrysops*). Cotypes, 6♀♀, West Fork Gila River, N. M. (lectotype, Philip, 1942); B.M.N.H. Philip, 1941, Rev. Ent., **12**:472; 1942, Ent. News, **53**:111; 1942 ("1940"), Rev. Chilena Hist. Nat., **44**:192. Male unknown. N. M., (Mexico).

Chrysops ceras. Hine, 1904, Ohio Nat., **5**:220; 1917, Trans. Amer. Ent. Soc., **43**:292; 1925, Occ. Pap. Mus. Zool. Univ. Mich., No. 162, p. 14 (synonym of *megaceras*). Philip, 1941, Proc. Ent. Soc. Wash., **43**:117 (correction synonymy).

CHRYSOPS Meigen, 1800,

Nouv. class., p. 23; 1803, Illiger's Mag., **2**:267. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:369 (k). Williston, 1886, Trans. Kans. Acad. Sci., **10**: 131 (k). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 32 (k); 1904, Ohio Nat., **5**:219 (k). Daecke, 1906, Ent. News, **17**:39 (f). Malloch, 1917, Bull. Ill. Lab. Nat. Hist., **12**:356 (lkf, pkf). Kröber, 1926, Stettin Ent. Ztg., **87**:209 (f, k, Nearctic monograph). Segal, 1933, Jour. N.Y. Ent. Soc., **44**:51-78, 125-154. Brennan, 1935, U. Kans. Sci. Bull., **22**:254 (synonymy, k, f). Johannsen, 1935, Cornell Expt. Sta. Mem. 177, Pt. II, p. 13 (lfk, pfk). Philip, 1941, Canad. Ent., **73**:9 (k). Genotype, *Tabanus caecutiens* "Fabricius" (=Linnaeus). desig. Latreille, 1810. The following synonymy is after Brennan (l.c).

Syn. Chrysopsis Dumeril, 1806, Zool. analytique, etc., p. 278 (nomen nudum); 1817, Dictionaire d, Sci. Nat., etc. **9**:169. Philip, 1942, Proc. N. Eng. Zool. Club, **21**:57. Genotype, "*Chrysopsis caecutiens*," desig. Philip, 1942.

Syn. *Nemorius* Rondani, 1856, Prodom. Dipt. Ital., I, p. 171. Genotype, *Chrysops vitripennis* Meigen, monotype.

Syn. *Haemophila* Kriechbaumer, 1873, Verh. Zool. Bot. Ges. Wien, **23**:70. Genotype, *Haemophila fallottii* Kriechbaumer (=*Chrysops vitripennis* Meigen) monotype.

Syn. *Haematophila* Verrall, in Scudder, 1882, Nom Zool., I, 152 (lapsus).

Syn. *Heterochrysops* Kröber, 1920, Zool. Jahrb., Abt. Syst., **43**:1-4, 50 and 55. Genotype, *Chrysops mlokosiewiczi* Bigot, orig. desig.

Syn. *Neochrysops* Szilady, 1922, Ann. Mus. Nat. Hung., **19**:126. Genotype, *Neochrysops grandis* Szilady, orig. desig. Not Walton, 1918, Proc. Ent. Soc. Wash., **20**:191.

Syn. *Ziemannia* Enderlein, 1923, Deutsche Ent. Zeit., p. 544. Genotype, *Chrysops laniger* Loew., orig. desig.

Syn. *Kleineana* Enderlein, 1923, Deutsche Ent. Zeit., p. 544. Genotype, *Chrysops longicornis* Macquart, orig. desig.

Syn. *Psylochrysops* Szilady, 1926, Zool. Anz., **66**:328 (change of name for *Neochrysops* Szilady, not Walton).

Syn. *Turanochrysops* Stakelberg, 1926, Bull. Ent. Research, **16**:326. Genotype, *Chrysops* (*Turanochrysops*) *hyalinipennis* Stackelberg, monotype.

Syn. *Chrisops* Fraga, 1936, Rev. Chilena Hist. Nat., **40**:248 (lapsus).

1. *abata* Philip, 1941, Proc. Ent. Soc. Wash., **43**:120 (f). Type, ♀, Jacksonville, Fla.; Coll. Philip. Male unknown. Fla.

2. *aberrans* Philip, 1941, Proc. Ent. Soc. Wash., **43**:122 (f, ♂). Type, ♀, Ramsay Co., Minn.; Coll. Philip. Minn., Ill., Ind., Ohio, Mich., Wisc., Iowa, Pa., N.J., N.Y., R.I., Mass., Conn., Me., Que.

Chrysops striata Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:391 (partim). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 43. Kröber, 1926, Stettin Ent. Ztg., **87**:343. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 35, 51, 92 (l, p). Brennan, 1935, U. Kans. Sci. Bull., **22**:341 (f). All partim.

abaestuans Philip, equals *aestuans* subsp.

3. *aestuans* van der Wulp, 1867, Tijdsch. v. Ent. **10**:135 (f). Type, ♀, "Kumlein," Wisconsin; Rijks. Mus., Leiden. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:378. Hart, 1895, Bull. Ill. Lab. Nat. Hist., **4**:227 (ef). Lugger, 1897, 2d Rep. Ent. Minn., p. 10 (f). Philip, 1931, Minn. Exp. Sta., Tech. Bull. No. 80, pp. 36, 82, 122, 124 (l, p, synonymy). Brennan, 1935, U. Kans. Sci. Bull., **22**:261 (f). Rowe and Knowlton, 1936, Ohio Jour. Sci., **36**:256 (f). Pechuman, 1938, Bull. Brooklyn Ent. Soc., **33**:136 (synonymy). Male, see *moerens* below. Que., Ont., Man., Sask., Alta., B.C., *Alas., N.Y., Mich., Ohio, *Ky., Ind., Ill., Wisc., Minn., N.D., S.D., Neb., Kans., Colo., *Wyo., Mont., Ida., Utah, *Nev., *N.M., *Calif., Ore., Wash.

Chrysops moerens Walker, 1848, List, I, p. 201. Type, ♀, Nova Scotia; B.M.N.H. Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:302. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 40 (♂); 1906, Bur. Ent. Tech. Ser. Bull. No. 12, pp. 36-38 (e, f); 1923, Ohio Jour. Sci., **23**:205. Wehr, 1924, Nebr. Univ. Studies, **22**:112. Cameron, 1926, Bull. Ent. Research., **17**:23 e, lf, pf). Kröber, 1926, Stettin Ent. Ztg., **87**:280 (f). Segal, 1936, Jour. N. Y. Ent. Soc., **44**:140. Not Fabricius, 1787, Mant. Ins., **4**:372.

3a. subsp. *abaestuans* Philip, 1941, Proc. Ent. Soc. Wash., **43**:121 (f, ♂). Type, ♀, Clark Co., Kans.; Coll. Philip. *Ia., Kans., Colo., *S.D., Sask.

3b. subsp. *confusa* Kröber, 1926, Stettin Ent. Ztg., **87**:284 (var. of *moerens* Walk.) (f). Type, ♀, Oliver, B. C.; C.N.C., No. 1342. Philip, 1941, Proc. Ent. Soc. Wash, **43**:121. Male unknown. B.C., *Wash.

Chrysops callida var. *confusa*. Brennan, 1935, U. Kans. Sci. Bull., **22**:271.

Chrysops callidus Williston, 1887, Trans. Kans. Acad. Sci., **10**:132; not Osten Sacken, 1887, Mem. Boston Soc. Nat. Hist., **2**:379.

4. *amazon* Daecke, 1905, Ent. News, **16**:250 (f). Cotypes, 4♀♀, Brown's Mills Junction, N. J.; U.S.N.M. Nos. 10258, 26607. Daecke, 1906, Ent. News, **17**:42 (f); 1907, Ent. News, **18**:140 (f). Kröber, 1926, Stettin Ent. Ztg., **37**:305 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:63 (♂, f). N.H., Mass., N.J.

approximans Walker, equals *Diachlorus ferrugatus*.
areolatus Walker, equals *vittata*.
atra Macquart, equals (?) *carbonaria*.
atricornis Bigot, equals *proclivus* (♀), *bishoppi* (♂).
atropos Osten Sacken, equals *divisa*.

5. *beameri* Brennan, 1935, U. Kans. Sci. Bull., **22**:265 (f). Type, ♀, Comanche Co., Kan.; U. Kan. Philip, 1941, Proc. Ent. Soc. Wash., **43** :116 (♂, synonymy). Kan., *Ark., Ill., *Ohio, Mass., *N.Y., *N.J., *Del., *Md., D.C., *Ga., N.C., Fla.

Chrysops sequax Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:306; Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:141 (f); Hine, 1907, La. Exp. Sta. Bull. No. 93, p. 34 (all partim). Not Williston, 1887, Trans. Kans. Acad. Sci., **10**:133.

6. *bishoppi* Brennan, 1935, U. Kans. Sci. Bull., **22**:266 (♂, f). Type, ♀, Topaz, California; U. Kan. Philip, 1941, Proc. Ent. Soc. Wash., **43**:117 (synonymy). Calif., Ore.

Chrysops coloradensis Philip, 1935, Proc. Ent. Soc. Wash., **37**:159 (partim); not Bigot, 1892, Mem. Soc. Zool. Fr., **5**:605.

Chrysops atricornis Bigot, 1892, Mem. Soc. Zool. Fr., **5**:603 (partim, ♂). Cotype, ♂ (only), Colo.; B.M.N.H.

7. *bistellata* Daecke, 1905, Ent. News, **16**:249 (f). Cotypes, 16♀♀, Brown's Mills Junction, N. J.; U.S.N.M. No. 26608, U. Kans. Daecke, 1906, Ent. News, **17**:42 (f); 1907, Ent. News, **18**:141 (f). Hine, 1907, La. Exp. Sta. Bull.

No. 93, p. 26 (f). Kröber, 1926, Stettin Ent. Ztg., **87**:238 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:267 (f). Male unknown. N.J., N.C., *Ga., La., Fla.

8. *brimleyi* Hine, 1904, Canad. Ent., **36**:55. Cotypes, unstated no. ♀♀, Raleigh, North Carolina; Ohio S. U., Pa. Dept. Agric., Coll. Philip. Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:140 (f). Greene, 1909, Ent. News, **20**:302 (♂, f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:196. Kröber, 1926, Stettin Ent. Ztg., **87**:269 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:268 (f). N.Y., N.J., Del., Md., Va., N.C., *Ga., Fla., Ala., Miss.

9. *brunnea* Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 34. Cotypes, unstated no. ♂♂, ♀♀, Sandusky, Ohio; Ohio S. U., U.S.N.M., Coll. Philip. Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:146 (f). Hine, 1907, La. Exp. Sta. Bull. No. 93, p. 26 (f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Kröber, 1926, Stettin Ent. Ztg., **87**:258. Brennan, 1935, U. Kans. Sci. Bull., **22**:270 (f, synonymy). Ont., N.Y., N.J., Del., Md., Va., N.C., Ga., Fla., Ala., La., Tex., Ariz., Kan., Ind., Ohio.

10. *callida* Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:379; not *Chrysops calidus* Walker, 1848, List, I, p. 205. Cotypes, 11♀♀ (lectotype, Ill., Fairchild, 1928); M.C.Z. No. 4011. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 35. Daecke, 1906, Ent. News, **17**:42 (f); 1907, Ent. News, **18**:145 (f). Hine, 1907, La. Exp. Sta. Bull. No. 93, p. 28 (♂, ♀f). Marchand, 1917, Jour. N.Y. Ent. Soc., **25**:150 (l, p); 1918, Trans. Amer. Ent. Soc., **44**:176 (f). Wher, 1924, Nebr. Univ., Studies, **22**:113. Kröber, 1926, Stettin Ent. Ztg., **87**:284 (f). Schwardt and Hall, 1930, Ark. Exp. Sta. Bull. No. 256, p. 14 (f). Stone, 1930, Ann. Ent. Soc. Amer., **23**:274 (l, p). Schwardt, 1936, Ark. Exp. Sta. Bull. No. 332, p. 18 (e, f). Philip, 1931, Minn. Exp. Sta. Bull. No. 80, pp. 37, 83, 123, 124 (l, pf). Brennan, 1935, U. Kans. Sci. Bull., **22**:271 (f). Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:28. Chagnon and Fournier, 1943, Nat. Canadien, **70**:70. Alta., Man., B.C., Ont., Que., Me., Mass., Conn., N.Y., N.J., Pa., Del., Md., D.C., Va., N.C., *Ga., Fla., Mich., Wisc., Minn., Ohio, *Ky., Ind., Ill., Neb., Iowa, Kan., *Mo., Miss., La., Tex., Ark., Okla., Colo., Mont., Wash.

Chrysops callidula Philip, 1941, Proc. Ent. Soc. Wash., **43**:117 (wrong change of name); 1942, Proc. N. Eng. Zool. Club, **21**:63 (synonymy).

******Chrysops moerens* confusus. Brennan (wrong synonymy).

callidula Philip, equals *callida*.
canadensis Kröber, equals *frigida*.
canifrons Walker, equals *flavida*.

11. *carbonaria* Walker, 1848, List, I, p. 203. Cotypes, 2♀♀, Nova Scotia; B.M.N.H. Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:303 (synonymy). Hine, 1904, Ohio Nat., **5**:220. Daecke, 1907, Ent. News, **18**:140 (f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Kröber, 1926, Stettin Ent. Ztg., **87**:245 (f). Stone, 1930, Ann. Ent. Soc. Amer., **23**:275 (lf, p). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 35, 84, 122 (l). Brennan, 1935, U. Kans. Sci. Bull., **22**:274 (f). Segal, 1936, Jour. N.Y. Ent. Soc., **44**:73. Rowe and Knowlton, 1936, Ohio Jour. Sci., **36**:256. N.S., N.F., Que., Ont., Man., *Sask., Alta., *B.C., Alas., Me., N.H., Mass., Conn., *R.I., N.Y., N.J., Del., Pa., Md., Va., D.C., N.C., Mich., Ohio, Wis., *N.D., S.D., Wyo., Neb., Colo., Mont., Ida., Utah, *Ore., Calif.

niger Walker, 1848, List, I, p. 202; not Macquart, 1838, Dipt. exot. nouv. peu connus, I, pt. 1, p. 161 (orig. Mem., Lille, 1838, p. 165).

provocans Walker, 1850, Dipt. Saund., I, p. 73. Type, ♀, Cape Breton; B.M.N.H. Philip, 1942, Proc. N. Eng. Zool. Club, **21**:65.

?*atra* Macquart, 1850, Dipt. exot. nouv. peu connus, Sup. IV, p. 40 (orig. Mem., Lille, 1850, p. 344). Type, ♀, New Foundland; collection unknown.

fugax Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:375. Cotypes, 14 ♀ ♀ (lectotype, ♀, Norway, Me., Fairchild, 1938); M.C.Z. No. 4008. Williston, 1886, Trans. Kans. Acad. Sci., **10**:132. Daecke, 1906, Ent. News, **17**:41 (f). Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:30.

carbonarius var. Walker, 1848, List, I, 203. Type, ♀, Nova Scotia; B.M.N.H.

12. *celeris* Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:376. Cotypes, 8 ♀ ♀ (lectotype ♀, Mass., Fairchild, 1938); M.C.Z. No. 4009. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 36 (♂). Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:39 (f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Kröber, 1926, Stettin Ent. Ztg., **87**:244. Stone, 1930, Ann. Ent. Soc. Amer., **23**:279 (l). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 84, 122 (l). Brennan, 1935, U. Kans. Sci. Bull., **22**:275 (f). Segal, 1936, Jour. N. Y. Ent. Soc., **44**:74. Fairchild, 1938, Proc. N. Eng. Zool Club, **17**:28. Philip, 1941, Proc. Ent. Soc. Wash., **43**:117. N.F., N.S., Que., Ont., *Man., Sask., Me., Mass., Conn., *R.I., N.Y., N.J., Del., Pa., Md., D.C., Va., N.C., *S.C., *Ga., Mich., Ind., Ill., Wis., Minn., Okla., Ark.

?*cincticornis* Walker, 1848, List, I, p. 201. Type, ♀, unknown locality; B.M.N.H. Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:302 (synonymy).

?*uter* Marchand, 1917, J. N. Y. Ent. Soc., **15**:149 (footnote, lapsus).

12a. subsp. *nigroptera* Fairchild, 1937, Fla. Ent., **19**:59. Type, ♀, Lloyd, Jefferson Co., Fla.; M.C.Z. No. 21, 977. Male unknown. Fla.

ceras Townsend, see *Assipala*.
cincticornis Walker, equals (?) *celeris*.
claripennis Krober, equals *hyalina*.

13. *clavicornis* Brennan, 1935, U. Kans. Sci. Bull., **22**:277 (f, synonymy, ♂). Type, ♀, San Diego, Calif.; Kan. U. Calif., *Nev.

Chrysops coquilletti Hine, 1904, Ohio Nat., **5**:220(partim).

14. *coloradensis* Bigot, 1892, Mem. Soc. Zool. Fr., **5**:605 (partim). Cotypes, 5 ♂ ♂, 5 ♀ ♀, Colorado; B.M.N.H. Ricardo, 1900, Ann. Mag. Nat. Hist., ser. 7, **8**:307. Hine, 1904, Ohio Nat., **5**:220. Webb and Wells, 1924, U.S.D.A., Dept. Bull. No. 1218, p. 31 (f). Kröber, 1926, Stettin Ent. Ztg., **87**:293 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:278 (f). Philip, 1935, Proc. Ent. Soc. Wash., **37**:158 (partim); 1941, Proc. Ent. Soc. Wash., **43**:117 (synonymy). Colo., Nev., Calif., Ore., Wash., B.C.

Chrysops pachycera Williston, 1887, Trans. Kans. Acad. Sci., **10**:134 (partim). Cotype, ♂ (only), Calif.; U. Kans., Cole and Lovett, 1921, Proc. Calif. Acad. Sci., **11**:232.
coloradensis Bigot (partim), equals *Chrysop fulvastra*.
coloradensis Philip (partim), equals *Chrysops bishoppi*.
confusa Kröber, equals *aestuans* subsp.
convergens Walker, equals *Diachlorus ferrugatus*.

15. *coquilletti* Hine, 1904, Ohio Nat., **5**:220 (partim). Cotypes, "number of specimens," both sexes (lectotype, ♀, Los Angeles Co., Calif., Brennan, 1935); Ohio S. U. Kröber, 1926, Stettin Ent. Ztg., **87**:263 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:279 (f, synonymy). Rowe and Knowlton, 1936, Ohio Jour. Sci., **36**:256 (f). Calif., Utah.

coquilletti Hine (partim), equals *Chrysops clavicornis*.
crassicornis van der Wulp, equals *virgulata*.
cuchix Ricardo (lapsus), equals *cuclux*.

16. *cuclux* Whitney, 1879, Canad. Ent., **11**:35. Cotypes, 17♀♀, Milford, N. Hamp.; B.S.N.H.? (see Philip, 1942). Daecke, 1907, Ent. News, **18**:140 (f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Kröber, 1926, Stettin Ent. Ztg., **87**:253. Stone, 1930, Ann. Ent. Soc. Amer., **23**:280 (lf, p). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 85, 122. Bequaert, 1933, Occ. Pap. Boston Soc. Nat. Hist., **8**:82. Brennan, 1935, U. Kans. Sci. Bull., **22**:281 (f, ♂). Philip, 1942, Proc. N. Eng. Zool. Club, **21**:65. N.S., Que., Ont., Me., N.H., Conn., Mass., N.Y., N.J., Pa., Md., Va., N.C., Mich.
Chrysops cuchix Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:300 (lapsus).

17. *cursim* Whitney, 1879, Canad. Ent., **11**:36. Cotypes, 6♀♀, Milford, N. Hamp.; all destroyed. Williston, 1887, Trans. Kans. Acad. Sci., **10**:134 (wrong synonymy). Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:300. Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:145 (f). Whitney, 1914, Canad. Ent., **46**:345. Bequaert, 1933, Occ. Pap. Boston Soc. Nat. Hist., **8**:82. Brennan, 1935, U. Kans. Sci. Bull., **22**:282 (♂). N.H., Mass., Conn., N.Y., N.J., Pa., Md., N.C., *Ga., Fla., *Ala.
Chrysops cursus Aldrich (lapsus), in Leonard 1926, Cornell U. Expt. Sta. Mem. 101, p. 754.
cursus Aldrich (lapsus), equals *cursim*.

18. *delicatula* Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:380. Cotypes, 2♀♀ (lectotype, ♀, North Conway, N. Hamp., Fairchild, 1938); M.C.Z. No. 4012. Daecke, 1906, Ent. News, **17**:42 (f); 1907, Ent. News, **18**:144 (f). Kröber, 1926, Stettin Ent. Ztg., **87**:265 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:283 (f). Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:29. Segal, 1936, Jour. N. Y. Ent. Soc., **44**:134. Male unknown. Me., Ont., N.H., Conn., *Mass., N.Y., N.J., Del., Mich.
dilata Rowe and Knowlton, equals *pachycera* subsp.

19. *dimmocki* Hine, 1905, Ohio Nat., **6**:393. Type, ♀, Long Meadow, Mass.; Ohio S. U. Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:145 (f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Kröber, 1926, Stettin Ent. Ztg., **87**:294 (f). Brennan, 1935, U. Kan. Sci. Bull., **22**:284 (♂, f). Segal, 1936, Jour. N.Y. Ent. Soc., **44**:135. Philip, 1941, Proc. Ent. Soc. Wash., **43**:117. Mass., Conn., N.Y., N.J., R.I., Pa., Del., Md., Va., N.C., Ga., Fla., *Mich.
Chrysops pudica Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:381 (partim). Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:33.

20. *discalis* Williston, 1880, Trans. Conn. Acad. Sci., **6**:245. Cotypes, 4♀♀, Como, Wyo.; one ♀, Kan. U. Hine, 1904, Ohio Nat., **5**:221 (♂). Wehr, 1924, Neb. Univ. Studies, **22**:112. Cameron, 1926, Bull. Ent. Research, **17**:18 (lf, pf, f). Brennan, 1935, U. Kan. Sci. Bull., **22**:286 (f). Rowe and Knowlton, 1936, Ohio Jour. Sci., **37**:257 (f). Philip, 1941, Proc. Mont. Acad. Sci., **2**:64-66 (f, p). Gjullin and Mote, 1945, Proc. Ent. Soc. Wash., **47**:236-244 (f, ef, pf). Man., Sask., Alta., B.C., N.D., Neb., Wyo., Mont., Colo., Utah, Nev., Calif., Ore., Wash., Ida.
Heterochrysops discalis. Kröber, 1926, Stettin Ent. Ztg., **87**:236 (f).

21. *dissimilis* Brennan, 1935, U. Kan. Sci. Bull., **22**:288 (♂, f). Type, ♀, Lost River, Chaves Co., N. Mex.; Kan. U. N.M.

22. *divisa* Walker, 1848, List, I, p. 204. Cotypes, 2♀♀, Florida; B.M.N.H. (one labelled type). Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:303 (synonymy). Brennan, 1935, U. Kans. Sci. Bull., **22**:289 (f). N.J., Fla.
Chrysops atropos Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:372. Cotypes, 18♀♀ (lectotype, ♀, Florida, Fairchild, 1938); M.C.Z. No. 4006. Kröber, 1926, Stettin Ent. Ztg., **87**:240 (f). Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:28.

23. *dorsovittata* Hine, 1907, Ohio Nat., **8**:229. Cotypes, ♀, ♂, Ga. and Fla.; Ohio S. U. Kröber, 1926, Stettin Ent. Ztg., **87**:325 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:290 (♂, f). Md., N.C., Ga., Fla.

dorsopuncta Fairchild, equals *fulvistigma* subsp.

24. *excitans* Walker, 1850, Dipt. Saund., **1**:72. Type, ♀, Cape Breton; B.M.N.H. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:373. Williston, 1887, Trans. Kans. Acad. Sci., **10**:132. Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:304. Howard, 1902, Insect Book (f). Hine, 1904, Ohio Nat., **5**:222. Daecke, 1907, Ent. News, **18**:139. Cameron, 1926, Bull. Ent. Research, **17**:19 (♂, lf, pf, f). Andrews, 1918, Occ. Pap. Mus. Zool. Univ. Mich. No. 53, p. 3. Kröber, 1926, Stettin Ent. Ztg., **87**:250. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 35, 85, 122, 123 (l, p, synonymy). Brennan, 1935, U. Kans. Sci. Bull., **22**:291. Segal, 1936, Jour. N.Y. Ent. Soc., **44**:77. Rowe and Knowlton, 1936, Ohio Jour. Sci., **36**:257 (f). N.F., N.S., Labrador, Ont., Que., Man., Sask., Alta., B.C., Me., Mass., N.H., N.Y., N.J., Mich., Wis., Minn., Ill., *N.D., Colo., *Wyo., Mont., Utah, *Calif., Ore., Wash., Alas.

Chrysops sordidus Washburn, 1905, 10th Rept. State Ent. Minn., p. 79. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80 pp. 85 (synonymy). Not Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:376.

25. *facialis* Townsend, 1897, Psyche, **8**:39. Type, ♀, West Fork, N. Mex.; B.M.N.H. (now headless). Hine, 1904, Ohio Nat., **5**:223 (♂). Kröber, 1926, Stettin Ent. Ztg., **87**:261. Brennan, 1935, U. Kans. Sci. Bull., **22**:292. Philip, 1935, Proc. Ent. Soc. Wash., **37**:160. Pechuman, 1939, Bull. Brooklyn Ent. Soc., **34**:242. N.M., Ariz., (Mexico).

Chrysops fascialis Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:300 (lapsus).
fallax Osten Sacken, equals *geminata*.
fascialis Ricardo (lapsus), equals *facialis*.
fascipennis Macquart, equals (?) *univittata*.
ferrugatus Fabricius, equals *Diachlorus ferrugatus*.

26. *flavida* Wiedemann, 1821, Dipt. Exot., **1**:105. Type, ♀, Savannah, Ga.; Univ. Zool. Mus., Copenhagen (not in Vienna Mus. as listed by Brennan, 1935). Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:385 (♂, synonymy). Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:300. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 37. Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:146 (f). Hine, 1907, La. Exp. Sta. Bull. No. 93, p. 29 (f); 1925, Occ. Pap. Mus. Zool. Univ. Mich. No. 162, p. 19. Kröber, 1926, Konowia, **4**:329; 1926, Stettin Ent. Ztg., **87**:291. Schwardt and Hall, 1930, Ark. Exp. Sta. Bull. No. 256, p. 14. Schwardt, 1931, Jour. Kans. Ent. Soc., **4**:7 (l); 1936, Ark. Exp. Sta. Bull. No. 332, p. 22 (l). Brennan, 1935, U. Kans. Sci. Bull., **22**:293 (f). Philip, 1941, Proc. Ent. Soc. Wash., **43**:118 (synonymy). Mass., Conn., *R.I., N.Y., N.J., Del., Md., Va., N.C., S.C., Ga., Fla., Ala., La., Tex., Ark., *Okla., Kan., Ill., Ind., Mich., Ohio, (Bahama Islands, Cuba, Mexico).

Chrysops canifrons Walker, List, I, p. 197. Type, ♀, Fla.; B.M.N.H.

Chrysops guiterasi Brunetti, 1923, Bull. Ent. Res., **13**:401. Types, ♂ ♀, Manzanillo, Cuba; B.M.N.H. and Deut. Ent. Inst., Berlin-Dahlem, respectively. Bequaert, 1940, Rev. de Ent., **11**:279 (synonymy).

?*Chrysops pallidus* Bellardi, 1859, Saggio Ditter. Messicana, I, p. 73 (f). Type, ♀, Mexico; probably Turin Museum. Not Macquart, 1838, Dipt. Exot., **1**:162.

26a. subsp. *reicherti* Fairchild, 1937, Fla. Ent., **19**:60. Type, ♀, Monticello, Jefferson Co., Fla.; M.C.Z. No. 25370. Philip, 1941, Proc. Ent. Soc. Wash., **43**:118 (synonymy). Male unknown. Del.?, Fla., *Ga., *La.

fraternus Kröber, equals *wiedemanni*.

27. *frigida* Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:384 (♂). Cotypes, 5♀♀ (lectotype, ♀, Sharon Springs, N. Y., Fairchild, 1938); M.C.Z. No. 4016. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:474. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 37; 1904, Ohio Nat., **5**:223. Daecke, 1907, Ent. News, **18**:145 (f). Cameron, 1926, Bull. Ent Research, **17**:20 (pf). Kröber, 1926, Stettin Ent. Ztg., **87**:330. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 86. Brennan, 1935, U. Kans. Sci. Bull., **22**:295 (f, synonymy). Fairchild, 1938, Proc. N. Ent. Zool. Club, **17**:29. N.B., N.F., Ont., Que., Man., Sask., Alta., B.C., Me., N.H., Conn., Mass., *R.I., N.Y., N.J., *Pa., Mich., Minn., Wis., Ohio, Colo., *Mont., *Ore., Wash.

Chrysops canadensis Kröber, 1926, Stettin Ent. Ztg., **87**:277 (♂, f). Type, ♂, Ottawa, Ont.; C.N.M. No. 2492.

frigidus Osten Sacken (partim), equals *Chrysops nigripes*.
fugax Osten Sacken, equals *carbonaria*.

28. *fuliginosa* Wiedemann, 1821, Dipt. Exot., **1**:109. Type, ♂, North America; presumably lost. Kröber, 1926, Stettin Ent. Ztg., **87**:311 (f, synonymy). Brennan, 1935, U. Kans. Sci. Bull., **22**:297 (f). Female, see *plangens* below. N.S., Me., Mass., R.I., Conn., N.Y., N.J., Del., *Md., Va., N.C., S.C., Ga., Fla.

Chrysops plangens Wiedemann, 1828, Auss. zweifl. Ins., **1**:210. Type, ♀, Savannah, Ga.; U. Berlin Mus. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:393 (synonymy). Daecke, 1906, Ent. News, **17**:42 (f); 1907, Ent. News, **18**:141 (f).

29. *fulvaster* Osten Sacken, 1877, West. Dipt., p. 221. Cotypes, 5♀♀, ♂ (lectotype, ♀, Denver, Colo., Fairchild, 1938); M.C.Z. No. 897. Williston, 1887, Trans. Kans. Acad. Sci., **10**:134. Hine, 1904, Ohio Nat., **5**:223. Wehr, 1924, Nebr. Univ. Studies, **22**:112. Cameron, 1926, Bull. Ent. Research, **17**:21 (lf, pf, f). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 86, 122. Brennan, 1935, U. Kans. Sci. Bull., **22**:298 (f). Rowe and Knowlton, 1936, Ohio Jour. Sci., **36**:257 (f). Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:30. Sask., Alta., Minn., N.D., S.D., Neb., Kan., Okla., Mont., Wyo., Colo., N.M., Ida., Utah, Ariz., Calif.

Chrysops coloradensis Bigot 1892, Mem. Soc. Zool. Fr., **5**:605 (partim). Ricardo, 1900, Ann. Mag. Nat. Hist., ser. 7, **8**:306 (synonymy).

Heterochrysops fulvaster. Kröber, 1926, Stettin Ent. Ztg., **87**:233; 1928, Deutsche Ent. Zeit., p. 427.

30. *fulvistigma* Hine, 1904, Canad. Ent., **36**:55. Cotypes, 2♀♀, Raleigh, N. C.; Ohio S. U. Daecke, 1907, Ent. News, **18**:146 (f). Hine, 1907, La. Exp. Sta. Bull. No. 93, p. 29. Kröber, 1926, Stettin Ent. Ztg., **87**:248 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:300 (f, ♂). N.C., Ga., La.

30a. subsp. *dorsopuncta* Fairchild, 1937, Fla. Ent., **19**:59. Type, ♀, Lloyd, Jefferson Co., Fla.; M.C.Z. No. 25369. Fla.

31. *furcata* Walker, 1848, List, I, p. 199. Type, ♀, St. Martin's Falls, Albany River, Hudson's Bay, Can.; B.M.N.H. Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:302. Brennan, 1935, U. Kans. Sci. Bull., **22**:301 (synonymy, f). Philip, 1935, Proc. Ent. Soc. Wash., **37**:153 (synonymy, ♂). Labr., N.B., *N.S., Que., Ont., Man., Sask., Alta., B.C., Yukon Terr., Alas., Mich., Wisc., Minn., S.D., *N.D., Mont., Wyo., Colo., Utah, *Ida., Ore., Calif., Wash., *Nev.

Chrysops lupus Whitney, 1904, Canad. Ent., **36**:205. Cotypes, 9♀♀, Grand Lake and Long's Peak, Colo.; M.C.Z. No. 17,054. Hine, 1904, Ohio Nat., **5**:224. Kröber, 1926, Stettin Ent. Ztg., **87**:304 (f). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 88 (♂). Bequaert, 1933, Occ. Pap. Boston Soc. Nat. Hist., **8**:83. Rowe and Knowlton, 1936, Ohio Jour. Sci., **36**:258 (f).

?*Chrysops proclivis* Cameron, 1926, Bull. Ent. Research, **17**:24 (lf, pf); not Osten Sacken, 1877, West. Dipt., p. 222.

furcatus Hine (not Walker), equals *Chrysops montana*.

32. *geminata* Wiedemann, 1828, Auss. zweifl. Ins., **1**:205. Type, ♀, patria ignota ("Vaterland?"); Vienna Nat. Mus. Kröber, 1926, Stettin Ent. Ztg., **87**:299 (synonymy, f). Brennan, 1935, U. Kans. Sci. Bull., **22**:303 (f). Segal, 1936, Proc. N. Y. Ent. Soc., **44**:138. Male, see *fallax* below. Que., Ont., N.H., Vt., Mass., Conn., *R.I., N.Y., N.J., Del., Pa., Md., D.C., Va., N.C., S.C., *Ga., Ohio, *Ky., Tenn., Ill., *Mich., Ga., Fla.

Chrysops fallax Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:392. Cotypes, 12♀♀, 2♂♂, (lectotype ♀, Tarrytown, N. Y., Fairchild, 1938); M.C.Z. No. 4021. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 36. Daecke, 1906, Ent. News, **17**, :40, 41 (f); 1907, Ent. News, **18**:141. McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Fairchild, 1938, Proc. N. Eng. Zool. Club., **17**:30.

32a. subsp. *impuncta* Kröber, 1926, Stettin Ent. Ztg., **87**:301 (f). Type, ♀, Port Stanley, Guelph, Ont., C.N.C. No. 1341. Brennan, 1935, U. Kans. Sci. Bull., **22**:304 (♂). Ont., Md., *S.C., Ohio, *Ky., *Tenn., *Mich.

geminatus Macquart (not Wiedemann), equals *virgulata*.

gigantulus Loew, equals *Silvius gigantulus*.

?*guiterasi* Brunetti, equals *flavida*.

hilaris Osten Sacken, equals *lateralis*.

33. *hinei* Daecke, 1907, Ent. News, **18**:143 (f). Cotypes, 17♀♀, various points in New Jersey; State Dept. Agr., Harrisburg, Pa., Ohio. S. U., U.S.N.M. Nos. 10328, 26605. Kröber, 1926, Stettin Ent. Ztg., **87**:338 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:305 (f). Philip, 1942, Proc. N. Eng. Zool. Club, **21**:64 (♂?). Mass., *R.I., N.J., *Va., N.C., S.C., Ga., Fla., Miss.

34. *hirsuticallus* Philip, 1941, Proc. Ent. Soc. Wash., **43**:126 (♂, f). Type, ♀, Woodland, Calif.; Coll. Philip. Calif.

hungerfordi Brennan, equals *pachycera* subsp.

35. *hyalina* Shannon, 1924, Proc. Ent. Soc. Wash., **26**:178 (change of name). Bequaert, 1930, Rept. Harvard-African Exped., etc., p. 890. Brennan, 1935, U. Kans. Sci. Bull., **22**:308 (synonymy). Philip, 1941, Proc. Ent. Soc. Wash., **43**:118. Male unknown. Md., *N.C.?, N.D. (fide Kröber).

Chrysops vitripennis Shannon, 1916, Ins. Insc. Menst., **4**:69. Type, ♀, Beltsville, Md.; U.S.N.M. No. 20301. McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:198. Not Meigen, 1820, Syst. Beschr., **2**:74 (f).

Nemorius claripennis Kröber, 1926, Stettin Ent. Ztg., **87**:230 (unjustified change of name).

imfurcatus Philip, equals *proclivus* subsp.

impunctus Kröber, equals *geminata* subsp.

36. *inda* Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:383. Cotypes, 2♀♀ (lectotype, ♀, Cayuga, N. Y., Fairchild, 1938); M.C.Z. No. 4015. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 38 (♂). Daecke, 1906, Ent. News, **17**:42 (f); 1907, Ent. News, **18**:141 (f). Kröber, 1926, Stettin Ent. Ztg., **87**:326. Stone, 1930, Ann. Ent. Soc. Amer., **23**:282 (l, p.). Philip,

1931, Minn. Expt. Sta. Tech. Bull. No. 80, pp. 38, 87, 123 (l, p). Brennan, 1935, U. Kans. Sci. Bull., **22**:309 (f). Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:31. Philip, 1941, Proc. Ent. Soc. Wash., **43**:118 (synonymy). Chagnon and Fournier, 1943, Nat. Canadien, **70**:51 (f). Que., Ont., N.H., Vt., Mass., Conn., N.Y., N.J., Del., Pa., *Md., N.C., Mich., Ohio, Ind., Ill., Wis., Minn., Colo.

Chrysops pilumnus Kröber, 1926, Stettin Ent. Ztg., **87**:329 (f). Type, ♂, Jordan, Ont.; C.N.C. No. 2491. Brennan, 1935, U. Kans. Sci. Bull., **22**:329.

lapponica Loew, equals *nigripes*.

37. *lateralis* Wiedemann, 1828, Auss. zweifl. Ins., **1**:209. Type, ♀, North America? (stated as "Vaterland?"); Vienna Nat. Mus. Kröber, 1926, Stettin Ent. Ztg., **87**:302 (synonymy, f). Hine, 1925, Occ. Pap. Mus. Zool. Univ. Mich. No. 162, p. 14 (wrong synonymy and distr.). Brennan, 1935, U. Kans. Sci. Bull. **22**:310 (♂). N.B., N.S., Que., Ont., Me., N.H., Vt., Mass., Conn., N.J., N.Y., Pa.

Chrysops hilaris Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:391. Cotypes, 12♀♀ (lectotype, ♀, New Hampshire, Fairchild, 1938); M.C.Z. No. 4020. Daecke, 1906, Ent. News, **17**:42. Howard, 1902, Insect Book (f). Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:30. (The "Kans." *hilaris* cotype record doubtful, especially since Fairchild's 1938 remarks indicate no label on "presumably the Kansas specimen.")

Chrysops pilaris Washburn, 1905, 10th Rept. Minn. State Entomologist, p. 95, (lapsus, also probable misidentification). Philip, 1931, Minn. Tech. Bull. No. 80, pp. 77, 93 (synonymy).

38. *latifrons* Brennan, 1935, U. Kans. Sci. Bull., **22**:312 (♂, f). Type, ♀, Fairbanks Ranch, Ash Meadows, Amargosa Desert, Nev.; A.N.S.P. Nev.

lineatus Jaennicke, equals *vittata*.

39. *lugens* Wiedemann, 1821, Dipt. Exot., I, p. 109. Type, ♂, Savannah, Ga.; Univ. Zool. Mus., Copenhagen (not "Vienna" Brennan, 1935). Wiedemann, 1821, Auss. zweifl. Ins., **1**:212. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 39 (♀). Daecke, 1907, Ent. News, **18**:142 (f). Hine, 1907, La., Exp. Sta. Bull. No. 93, p. 30. McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Kröber, 1926, Stettin Ent. Ztg., **87**:315 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:313 (f). Philip, 1941, Proc. Ent. Soc. Wash., **43**:118. Conn., N.Y., N.J., Del., Md., D.C., Va., N.C., Ga., Fla., Ala., La., Ohio, Ill., *Mich.

Chrysops morosus Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:389 (partim, one cotype). Fairchild, 1938, Proc. N. Ent. Zool Club, **17**:32.

lugens Hine (not Wiedemann), equals *obsoleta*.
lupus Whitney, equals *furcata*.

40. *luteopennis* Philip, 1935, Proc. Ent. Soc. Wash., **37**:159. Type, ♀, Moore's Lake, Anoka Co., Minn.; U. Minn. Male unknown. Minn., Ohio.

maechus Segal (lapsus), equals *moechus*.

41. *mitis* Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:374. Cotypes, 9♀♀ (lectotype, ♀, Hudson's Bay, Canada, Fairchild, 1938); M.C.Z. No. 4007. Hine, 1904, Ohio Nat., **5**:224. Daecke, 1907, Ent. News, **18**:140 (f). Kröber, 1926, Stettin Ent. Ztg., **87**:247 (♂). Cameron, 1926, Bull. Ent. Research, **17**:22 (lf, pf). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 34, 89, 122. Brennan, 1935, U. Kans. Sci. Bull., **22**:314 (f). Segal, 1936, Jour. N.Y. Ent., **44**:125. Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:31. Rowe and Knowlton, 1936, Ohio Jour. Sci., **36**:258 (f). Labr., Que., Ont., Man., Sask., Alta., B.C., *Alas., Me., N.H., Vt., Mass., R.I., N.Y.,

N.J.?, *Pa., Mich., Wis., Ill., Minn., N.D., *S.D., Mont., Wyo., Colo., Ida., Utah, Calif., Ore., Wash.

?*Chrysops provocans*. Kröber (l.c., p. 215) cites this doubtful synonymy, but places also under *carbonaria* (p. 245). Philip, 1942, Proc. N. Eng. Zool. Club, **21**:65. (type lacks both wings).

42. *moecha* Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:315. Cotypes, 2♀♀, 3♂♂ (lectotype, ♀, D.C., Fairchild, 1938); M.C.Z. No. 4017. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 39. Daecke, 1906, Ent. News, **17**:40 (f); 1907, Ent. News, **18**:141 (f). Hine, 1907, La. Exp. Sta. Bull. No. 93, p. 31 (♂ ♀ f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Kröber, 1926, Stettin Ent. Ztg., **87**:332 (f). Schwardt and Hall, 1930, Ark. Exp. Sta. Bull. No. 256, p. 14 (f). Stone, 1930, Ann. Ent. Soc. Amer., **23**:283 (lf, p). Philip, 1931, Minn. Expt. Sta. Tech. Bull. No. 80, p. 89. Brennan, 1935, U. Kans. Sci. Bull., **22**:315 (f). Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:31. Que., Me., N.H., Mass., Conn., *R.I., N.Y., N.J., Del., Pa., Md., D.C., Va., W.Va., N.C., Ga., Mich., Ohio, Ill., *Wis., Minn., Tenn., Mo., Miss., Ark., Kan., Okla., Ky., La.

Chrysops maechus Segal, 1936, Jour. N.Y. Ent. Soc., **44**:147 (lapsus).

moerens Walker, equals *aestuans*.

43. *montana* Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:382. Cotypes 3♀♀ (lectotype, ♀), Catskill Mountain House (Palenville), N. Y., Fairchild, 1938); M.C.Z. No. 4014. Townsend, 1895, Trans. Amer. Ent. Soc., **22**:57. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 40 (♂). Daecke, 1906, Ent. News, **17**:39 (f); 1907, Ent. News, **18**:145 (f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Marchand, 1918, Trans. Amer. Ent. Soc., **44**:176 (f). Kröber, 1926, Stettin Ent. Ztg., **87**:298 (f). Stone, 1930, Ann. Ent. Soc. Amer., **23**:284 (l, p). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 36, 90, 122 (pf). Brennan, 1935, U. Kans. Sci. Bull., **22**:316 (synonymy, f). Segal, 1936, Jour. N. Y. Ent. Soc., **44**:131. Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:32. Que., Ont., N.H., Vt., Mass., Conn., *R.I., N.Y., N.J., D.C., Md., N.C., Fla., *Ga., La., Mich., Ohio, Ind., Ill., Minn.

Chrysops furcatus Hine, 1904, Ohio Nat., **5**:223; Kröber, 1926, Stettin Ent. Ztg., **87**:296. Not Walker, 1848, List, I:199.

morosus Osten Sacken, equals *obsoleta, parvula* (partim), *lugens* (partim).

niger Walker (not Macquart), equals *carbonaria*.

44. *nigra* Macquart, 1838, Dipt. exot. nouv. peu connus, I, pt. 1, p. 161 (orig. Mem., Lille, 1838, p. 165). Type, ♀, North America; Lille Mus. N.H. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:377 (synonymy). Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:301 (synonymy). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 41 (♂). Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:140 (f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Kröber, 1926, Stettin Ent. Ztg., **87**:241, Deutsche Ent. Zeit., p. 429. Stone, 1930, Ann. Ent. Soc. Amer., **23**:285 (lf, p). Schwardt and Hall, 1930, Ark. Exp. Sta. Bull. No. 256, p. 13 (f). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 91. Brennan, 1935, U. Kans. Sci. Bull., **22**:318 (f). N.F., N.S., Que., Ont., Me., N.H., Mass., R.I., Conn., N.Y., N.J., Del., Md., Pa., D.C., Va., N.C., *Ga., Tenn., *Ky., Ohio, Ind., Ill., Mich., Minn., Ia., Mont., Ark., Mo.

Chrysops carbonarius var. β Walker, List, I, 203. Type, ♀, Nova Scotia; B.M.N.H.

nigricornis Matsumura, equals *Chrysops nigripes*.

45. *nigribimbo* Whitney, 1879, Canad. Ent., **11**:35. Cotypes, unstated no. ♀♀, Milford, N. H.; 2, M.C.Z. No. No. 4023, 1, B.S.N.H. Daecke, 1906, Ent. News,

17:41 (f); 1907, Ent. News, **18**:141 (f). Bequaert, 1933, Occ. Pap. Boston Soc. Nat. Hist., **8**:83. Brennan, 1935, U. Kans. Sci. Bull., **22**:319 (♂, f). N.H., Mass., R.I., N.Y., N.J., Del., N.C., Fla.

Chrysops nigrilimbo Aldrich, 1907, Jour. N. Y. Ent. Soc., **15**:8 (unjustified change of name). Surcouf, 1921, Gen. Insec., Fasc. 175, p. 153.

Chrysops nigrobimbo Johnson, 1925, Occ. Pap. Boston Soc. Nat. Hist., VII. 99 (lapsus).

nigrilimbo Aldrich, equals *nigribimbo*.

46. *nigripes* Zetterstedt, 1838, Ins. Lappon Dipt., p. 519, Type, ♀, No. Lappland ("Nord-Cap"); Zool. Univ. Mus., Lund. Zetterstedt, 1842, Dipt. Scand., I, 125. Loew, 1858, Verh. Z. B. Ges. Wien, **8**:623. Osten Sacken, Mem. Boston Soc. Nat. Hist., **2**:394. Hine, 1904, Ohio Nat., **5**:224; 1923, Canad. Ent., **55**:145. Kröber, 1926, Stettin Ent. Ztg., **87**:323 (♂). Brennan, 1935, U. Kans. Sci. Bull., **22**:320 (f). Olsoufiev, 1937, [Faune de l'URSS. Insectes Dipteres, Fam. Tabanidae], **7**:70 (f, synonymy). Philip, 1942, Proc. N. Eng. Zool. Club, **21**:63. Alas., Man., Alta., Ida., Mont., Me. [No. Europe, Siberia, Sakhalin Is.]

Chrysops lapponica Loew, 1858, Verh. B. Ges. Wien, **8**:624. Type, ♀, Lappland; presumably Berlin Mus. Not Brennan, 1935, U. Kans. Sci. Bull., **22**:378 (spec. from N. B.).

Chrysops nigricornis Matsumura, 1911, J. College Agr. Tohoku Imp. Univ. Sapporo, Japan, **4**:66. Type, ♀, Solowiyofka, Sakhalin; presumably Tohoku Imp. U. Shiraki, T., 1918, Taihoku Agr. Exp. Sta., Formosa, p. 77 (f).

Chrysops frigidus Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:384 (partim, one cotype, Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:29).

nigriventris Bigot, equals *pertinax*.

nigrobimbo Johnson (lapsus), equals *nigribimbo*.

nigroptera Fairchild, equals *celeris* subsp.

47. *noctifera* Osten Sacken, 1877, West. Dipt., p. 220. Cotypes, 4♀♀ (lectotype, ♀, Webber Lake, Cal., Fairchild, 1938); M.C.Z. No. 896. Hine, 1904, Ohio Nat., **5**:224 (synonymy). Cole, 1927, Proc. Cal. Acad. Sci., **16**:420, 469 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:321 (synonymy). Philip, 1941, Proc. Ent. Soc. Wash., **43**:118 (synonymy). Male unknown. Cal., N.M.

Chrysops sp. near *sordidus* Essig, 1928, Pan. Pac. Ent., **4**:186.

47a. subsp. *pertinax* Williston, 1887, Trans. Kans. Acad. Sci., **10**:132 (as *Chrysops pertinax*). Cotypes, 8♀♀ (lectotype, ♀, Wash. Terr., Brennan, 1935); U. Kan., 2♀♀. Philip, 1941, Proc. Ent. Soc. Wash., **43**:118 (synonymy).

Chrysops pertinax. Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:307 (synonymy). Brennan, 1935, U. Kans. Sci. Bull., **22**:327 (reinstates, f, ♂). Ont., Alta., B.C., Mich., Mont., Wyo., *Colo., Utah, Ida., Wash., Ore., Cal., ?N.H., (fide Kröber).

Chrysops nigriventris Bigot, 1892, Mem. Soc. Zool. Fr., **5**:604. Cotypes, 7♀♀, Wash. Terr.; B.M.N.H.

Chrysops noctifer Hine, 1904, Ohio Nat., **5**:224 (partim); Kröber, 1926, Stettin Ent. Ztg., **87**:308 (♂) (partim); Rowe and Knowlton, 1936, Ohio Jour. Sci. **36**:258 (f). Not Osten Sacken, 1877, West Dipt., p. 220.

48. *obsoleta* Wiedemann, 1821, Dipt. Exot., I, p. 108. Type, ♀, Georgia; Vienna Nat. Mus. Wiedemann, 1828, Auss. zweifl. Ins., **1**:211 (♂). Kröber, 1926, Stettin Ent. Ztg., **87**:315 (synonymy, f). Brennan, 1935, U. Kans. Sci. Bull., **22**:322 (synonymy, f). Mass., Conn., N.Y., N.J., Del., Pa., Md., D.C., N.C., Ga., Fla., La., *Tenn., Ohio.

?*Chrysops trinotata* Macquart, 1838, Dipt. exot. nouv. peu connus, I, pt. 1, p. 161

(orig. Mem., Lille, 1838, p. 165). Type, ♀, Philadelphia, Pa.: collection unknown.

Chrysops morosus Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:389, (1876): 474. Cotypes, 6♀♀, 1♂, Maryland (lectotype, ♀, Fairchild, 1938); M.C.Z. No. 4018. Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:32.

Chrysops lugens Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 39; 1907, La. Exp. Sta. Bull. No. 93, p. 30 (partim). Not Wiedemann, 1821, Dipt. Exot., I, p. 109.

Chrysops lugens var. *morosus*. Daecke, 1907, Ent. News, **18**:142.

obsoletus of authors (not Wiedemann), equals *wiedemanni*.

49. *ornata* Kröber, 1926, Stettin Ent. Ztg., **87**:328 (f). Type, ♀, Jordan, Ont.; Zool. Mus. Hamburg. Brennan, 1935, U. Kans. Sci. Bull., **22**:324. Male unknown. Ont.

pachycera Williston (partim), equals *coloradensis*.

50. *pachycera* Williston, 1887, Trans. Kans. Acad. Sci., **10**:134 (partim). Cotypes, 3 specimens, both sexes, California; ♀♀, lost, ♂, U. Kans. (♂ not *pachycera*, see Adams, 1903, Philip, 1935). Townsend, 1895, Proc. Cal. Acad. Sci., ser. 2, **4**:596 (wrong ♂). Adams, 1903, U. Kans. Sci. Bull., **2**:442 (Type ♂ = *C. proclivus*, misdetermination, see Philip, 1941). Hine, 1904, Ohio Nat., **5**:224. Kröber, 1926, Stettin Ent. Ztg., **87**:264. Brennan, 1935, U. Kans. Sci. Bull., **22**:324 (f). Philip, 1935, Proc. Ent. Soc. Wash., **37**:155 (footnote); 1941, **43**:119 (synonymy, redescribes ♂). Cal., Nev., Utah, Ariz.

50a. subsp. *dilata* Rowe and Knowlton, 1936, Ohio Jour. Sci., **36**:256 (f, ♂) (as *Chrysops dilatus*). Type, ♀, Leeds, Utah; U.S.N.M. No. 53630. Philip, 1941, Proc. Ent. Soc. Wash., **43**:119 (synonymy).

50b. subsp. *hungerfordi* Brennan, 1935, U. Kans. Sci. Bull., **22**:306 (f, ♂) (as *Chrysops hungerfordi*.). Type, ♀, Blue Spring, Eddy Co., N. Mex.; U. Kans. Phylop. 1941, Proc. Ent. Soc. Wash., **43**:119 (synonymy). Tex., Ariz., N.M.

pachycera Cole and Lovett (not Williston), equals *coloradensis*.

pachycera Williston (partim), equals *coloradensis*.

pallidus Bellardi, (not Macquart) equals *flavida*.

51. *parvula* Daecke, 1907, Ent. News, **18**:142 (f). Cotypes, 102♀♀, 4 N.J. localities, particularly Bamber; Daecke Coll., Harrisburg, Pa., U.S.N.M. No. 10327, Philip Coll. McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Kröber, 1926, Stettin Ent. Ztg., **87**:314. Schwardt and Hall, 1930, Ark. Exp. Sta. Bull. No. 256, p. 13. Brennan, 1935, U. Kans. Sci. Bull., **22**:326 (synonymy, f, ♂?). N.J., N.Y., Md., Va., N.C., Fla., Ark.

Chrysops morosus Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:390 (partim).

52. *pechumani* Philip, 1941, Proc. Ent. Soc. Wash., **43**:128 (♂). Type, ♀, Niles, Alameda Co., Calif.; Coll. Philip. Philip, 1942, Proc. N. Eng. Zool. Club, **21**:65. Calif.

pertinax Williston, equals *noctifera* subsp.

picea Philip, equals *proclivus* subsp.

53. *pikei* Whitney, 1904, Canad. Ent., **36**:205. Cotypes, 11♀♀, Pike Co., Mo. (lectotype, ♀, Philip, 1941); Pa. Dept. Agr., Harrisburg, Pa. Hine, 1904, Ohio Nat., **5**:224; 1907, La. Exp. Sta. Bull. No. 93, p. 33 (wrong f). Wehr, 1924, Neb. Univ. Studies, **22**:113. Kröber, 1926, Stettin Ent. Ztg., **87**:336 (f). Schwardt and Hall, 1930, Ark. Exp. Sta. Bull. No. 256, p. 13. Schwardt, 1936, Ark. Exp. Sta. Bull. No. 332, p. 25 (ef). Bequaert, 1933, Occ. Pap.

Boston Soc. Nat. Hist., **8**:83. Brennan, 1935, U. Kans. Sci. Bull., **22**:328 (♂, f). Philip, 1941, Proc. Ent. Soc. Wash., **43**:118. N.Y., N.J., N.C., *S.C., Ala., *Ga., Miss., La., Tex., Okla., Ark., Mo., *Ky., Kan., Neb., Iowa, Ill., Ind., Ohio, *Mich.

pilaris Washburn (lapsus), equals *striata*.
pilumnus Kröber, equals *inda* ♂.
plangens Wiedemann, equals *fuliginosa*.

54. *proclivus* Osten Sacken, 1877, West. Dipt., p. 222. Cotypes, 4♀♀ (lectotype, Marin Co., Calif., Fairchild, 1938); M.C.Z. No. 898. Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:306 (synonymy). Hine, 1904, Ohio Nat., **5**:225. Kröber, 1926, Stettin Ent. Ztg., **87**:320. Brennan, 1935, U. Kans. Sci. Bull., **22**:330 (f). Philip, 1935, Proc. Ent. Soc. Wash., **37**:155 (synonymy); 1941, **43**:119 (♂) Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:33. N.B., Que., Alta., Sask.?, Yukon Terr., B.C., Wash., Ore., Calif., Colo.?, Ariz.?

Chrysops atricornis Bigot, 1892, Mem. Soc. Zool. Fr., **5**:603 (partim). Cotype, ♀ (only), Colo.; B.M.N.H.

54a. subsp. *imfurcata* Philip, 1935, Proc. Ent. Soc. Wash., **37**:157. Type, ♀, Sumner, Wash.; Coll. . Philip. Male unknown. Ore., *Calif., *Wash., *B.C.

54b. subsp. *picea* Philip, 1935, Proc. Ent. Soc. Wash., **37**:157. Type, ♀, Huntington Lake, Calif.; Coll. Philip. Male unknown. Calif.

54c. subsp. *surda* Osten Sacken, 1877, West. Dipt., p. 223 (as *Chrysops surdus*). Cotypes 4♀ ♀ (lectotype, Webber Lake, Calif., Fairchild, 1938); M.C.Z. No. 899. Philip, 1935, Proc. Ent. Soc. Wash., **37**:155 (synonomy). Male unknown. B.C., Wash., Ore., Calif., Nev.

Chrysops surdus. Williston, 1887, Trans. Acad. Sci., **10**:134. Hine, 1904, Ohio Nat., **5**:226. Kröber, 1926, Stettin Ent. Ztg., **87**:322 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:342 (f).

proclivis Cameron (not Osten Sacken), equals (?) *Chrysops furcata*.
provocans Walker, equals (?) *carbonaria* (note, Kröber, 1926, also places under *mitis* with a question but the type now lacks both wings).

55. *pudica* Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:381. Cotypes, 4♀♀ (lectotype Beverly, Mass., Fairchild, 1938); M.C.Z. No. 4013. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:474. Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:145 (f). Hine, 1907, La. Exp. Sta. Bull. No. 93, p. 33. Marchand, 1918, Trans. Amer. Ent. Soc., **44**:176 (f). Kröber, 1926, Stettin Ent. Ztg., **87**:289 (*cursim* Whitney, a synonym). Bequaert, 1933, Occ. Pap. Boston Soc. Nat. Hist., **8**:82. Brennan, 1935, U. Kans. Sci. Bull., **22**:332 (f, ♂). Fairchild, 1938, Proc. N. Eng. Zool. Club, **17**:33. Mass., Conn., R.I., N.Y., N.J., Del., N.C., *S.C., Ga., Fla., La., Ark., *Mich., Ill.?

pudica Osten Sacken (partim), equals *sackeni*.
quadrivittata Say, see *Silvius*
reicherti Fairchild, equals *flavida* subsp.

56. *robusta* Brennan, 1935, U. Kans. Sci. Bull., **22**:333 (f, ♂). Type, ♀, Los Angeles, Calif.; U. Kan. Calif.

57. *sackeni* Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 42. Cotypes, unstated no. ♂♂, ♀♀, Sandusky, Ohio; Ohio State U., 2♂♂, 3♀♀. Daecke, 1907, Ent. News, **18**:145 (f). Kröber, 1926, Stettin Ent. Ztg., **87**:287 (f). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 39, 95, 122, 123 (l, p). Bequaert, 1933, Occ. Pap. Boston Soc. Nat. Hist., **8**:83. Brennan, 1935, U. Kans. Sci. Bull., **22**:335 (f). Que., Ont., Vt., Mass., R.I., Conn., N.Y., N.J., N.C., Fla., Tenn., Ohio, Ind., Mich., Ill., Wis., Minn., Iowa, Utah?

C. pudica Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:382 (partim, "observation").

58. *separata* Hine, 1907, Ohio Nat., **8**:228. Type, ♀, Raleigh, N. C.; Ohio S. U. Kröber, 1926, Stettin Ent. Ztg., **87**:311. Brennan, 1935, U. Kans. Sci. Bull., **22**:336 (f, ♂). N.C., Miss., La., Okla.

sequax Ricardo (not Williston), equals *beameri.*

59. *sequax* Williston, 1887, Trans. Kans. Acad. Sci., **10**:133. Cotypes, 4♀♀, 1♂, Western Kansas; U. Kan., ♀, ♂. Hine, 1904, Ohio Nat., **5**:225; 1907, La. Exp. Sta. Bull. No. 93, p. 34. McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:198. Wehr, 1924, Nebr. Univ Studies, **22**:113. Kröber, 1926, Stettin Ent. Ztg., **87**:345 (f). Schwardt and Hall, 1930, Ark. Exp. Sta. Bull. No. 256, p. 14. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 92. Brennan, 1935, U. Kan. Sci. Bull., **22**:337 (f). Mass., N.J., Del., Md., Va., N.C., S.C., Ga., Ohio, Ind., Ill., *Mich., Minn., Iowa, S.D., Neb., Iowa, Kan., Okla., Ark., Colo. Note: Eastern records may be confused with *beameri* Brennan as those of Daecke and others.

60. *shermani* Hine, 1907, Ohio Nat., **8**:229. Cotypes, 6♀♀, Highlands, N.C., and Hayden, Ont.; Ohio S.U. and M.C.Z. No. 7519. Kröber, 1926, Stettin Ent. Ztg., **87**:347 (f). Brennan, 1935, U. Kan. Sci. Bull., **22**:33. Chagnon and Fournier, 1943, Nat. Canadien, **70**:68. Male unknown. Que., Ont., Mich., N.Y., Pa., N.C.

61. sordida Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:376. Cotypes, 9♀♀, White Mts., N.H. (lectotype, Fairchild, 1938); M.C.Z. No. 4010, 5♀♀, A.N.S.P., ♀. Kröber, 1926, Stetin Ent. Ztg., **87**:249 (f). Brennan, 1935, U. Kan. Sci. Bull., **22**:340 (f). Chagnon and Fournier, 1943, Nat. Canadien, **70**:67. Male unknown. Labr., N.F., Que., Me., N.H., N.Y.

sordidus Washburn (not Osten Sacken), equals *excitans.*

62. *striata* Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:391. Cotypes, 6♀♀ (lectotype, "D.C.?", Fairchild, 1938); M.C.Z. No. 4019. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 43 (♂). Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:141 (f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:198. Hine, 1925, Occ. Pap. Mus. Zool. Univ. Mich. No. 162, p. 20. Kröber, 1925, Konowia, **4**:331; 1926, Stettin Ent. Ztg., **87**:343. Stone, 1930, Ann. Ent. Soc. Amer., **23**:287 (l, p). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 92 (partim, see *aberrans*). Brennan, 1935, U. Kans. Sci. Bull., **22**:341 (wrong f, see *aberrans*). Philip, 1941, Proc. Ent. Soc. Wash., **43**:125 (redescribes true ♂). Que., Ont., Me., N.H., Mass., Conn., N.Y., N.J., Pa., Md., D.C., Va., N.C., La., Ohio, Ind., Ill., *Mich., Wis., Minn. (Mexico). Note: Some of these records may be based on *aberrans* Philip.

Chrysops pilaris Washburn, 1905, 10th Rept. State Ent. Minn., p. 79 (lapsus). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 93 (synonymy).

Chrysops vittatus Bellardi, 1859, Saggio Ditter. Messico, **1**:74; not Wiedemann, 1821, Dipt. Exot., I, p. 106.

surdus Osten Sacken, equals *proclivus* subsp.

trinotata Macquart, equals (?) *obsoleta.*

63. *ultima* Whitney, 1914, Canad. Ent., **46**:345. Type, ♀, West Palm Beach, Fla.; M.C.Z. No. 17,056, damaged. Kröber, 1926, Stettin Ent. Ztg., **87**:322. Bequaert, 1933, Occ. Pap. Boston Soc. Nat. Hist., **8**:84. Brennan, 1935, U. Kans. Sci. Bull., **22**:343 (f). Male unknown. N.Y., N.J., Md., N.C., S.C., Fla.

64. *univittata* Macquart, 1855, Dipt. exot. nouv. peu connus, Sup. V, p. 36 (orig. Mem., Lille, 1855, p. 56). Cotypes, Unstated no. ♀♀, Baltimore, Md.; Mus. Lille.

Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:387. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 44 (♂). Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:141 (f). Hine, 1907, La. Exp. Sta. Bull. No. 93, p. 34. Marchand, 1918, Trans. Amer. Ent. Soc., **44**:177 (f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:198. Kröber, 1926, Stettin Ent. Ztg., **87**:335 (f). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 93. Brennan, 1935, U. Kans. Sci. Bull., **22**:344 (f). Que., Me., N.H., Mass., Conn., R.I., N.Y., N.J., Pa., Del., Md., D.C., Va., N.C., Ga., Fla., La., Kans., *Neb., Ill., Ind., Ohio, Mich., Wis., Minn.

?*Chrysops fascipennis* Macquart, 1834, Hist. Nat. Dipt., **1**:216. Type, ♀, Philadelphia; collection unknown.

"*uter* O. S." Marchand (lapsus), equals *celeris* (?).

65. *virgulata* Bellardi, 1859, Saggio Ditter. Messico, **1**:71 (f). Type, ♂, Cuautla, Mexico; Mus. Turin. Williston, 1901, Biol. Cent. Amer., **1**:255 (synonymy). Hine, 1904, Ohio Nat., **5**:226 (♀). Kröber, 1925, Konowia, **4**:235; 1926, Stettin Ent. Ztg., **87**:256. Brennan, 1935, U. Kans. Sci. Bull., **22**:345 (f). Tex., Ariz., *Calif. (Mexico).

Chrysops crassicornis van der Wulp, 1884, Ent. Ztg., **3**:141. Type, ♀, Guanaxuato, Mexico; Brussels Mus.

Chrysops geminatus Macquart, 1850, Dipt. exot. neuv. peu connus, Sup. IV, p. 39 (♀) (orig. Mem., Lille, 1850, p. 343). Not Wiedemann, 1828, Auss zweiflI Ins., p. 205. Mexico.

vitripennis Shannon, equals *hyalina*.

vittatus Bellardi (not Wiedemann), equals *striata*.

66. *vittata* Wiedemann, 1821, Dipt. Exot., I, p. 106. Type, ♀, Baltimore, Md.; collection unknown. Wiedemann, 1828, Auss. zweifl. Ins., **1**:200. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:390 (♂). Hart, 1895, Bull. Ill. Lab. Nat. Hist., **4**:228 (lf, p). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 44. Daecke, 1906, Ent. News, **17**:41 (f); 1907, Ent. News, **18**:141 (f). Hine, 1907, La. Expt. Sta. Bull. No. 93, p. 35 (f). Malloch, 1917, Bull. Ill. Lab. Nat. Hist., **12**:357 (lf, pf). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:198. Marchand, 1918, Trans. Amer. Ent. Soc., **44**:177 (f). Wehr, 1924, Nebr. Univ. Studies, **22**:113. Kröber, 1926, Stettin Ent. Ztg., **87**:339. Schwardt and Hall, 1930, Ark. Ext. Sta. Bull. No. 256, p. 14 (f). Stone, 1930, Ann. Ent. Soc. Amer., **23**:288 (lf, p). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 94. Brennan, 1935, U. Kans. Sci. Bull., **22**:347 (f). N.S., Que., Ont., Me., N.H., Mass., R.I., Conn., N.Y., Pa., N.J., Del., Md., D.C., Va., N.C., S.C., Ga., Fla., Ala., Miss., La., *Tex., Ark., Mo., Tenn., *Ky., Kan., Neb., Iowa, Ill., Ind., Ohio, Mich., Wis., Minn.

Chrysops areolatus Walker, 1848, List, I, 197. Type, ♀, New York; B.M.N.H. Ricardo, 1901, Ann. Mag. Nat. Hist., ser. 7, **8**:301.

Chrysops lineatus Jaennicke, 1867, Neue Exot. Dipt., p. 334. Type, ♀, Illinois; Coll. Schaufuss?

66a. subsp. *floridana* Johnson, 1913, Bull. Amer. Hus. Nat. Hist., **32**:52. Cotypes, unstated no. ♀♀, Horse Landing, Palatka and Enterprise, Fla.; M.C.Z. No. 7516, and Coll. Philip. Kröber, 1926, Stettin Ent. Ztg., **87**:341 (f). Brennan, 1935, U. Kans. Sci. Bull., **22**:348. Male unknown. Va., *S.C., Ga., N.C., Fla.

67. *wiedemanni* Kröber, 1926, Stettin Ent. Ztg., **87**:267 (f). Cotypes, unstated no. ♀♀, Springfield and Cohasset, Mass.; Orilla, Ont.; Ft. Coulogne and Veudrenil, Que.; Conn.; Lockbourne, Ohio, Opelousas, La.; Raleigh, N.C.; C.N.M. No. 2493, Vienna Nat. Mus. Stone, 1930, Ann. Ent. Soc. Amer., **23**:290 (lf, p). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 39, 94, 123. Bren-

nan, 1935, U. Kans. Sci. Bull., **22**:348 (f). Male, see "*obsoletus*" below. Que., Ont., Me., N.H., Mass., Conn., *R.I., N.Y., N.J., Pa., Del., Md., D.C., Va., N.C., S.C., Ga., Miss., La., Tenn., Ark., *Ky., Neb., Iowa, Ill., Ohio, Mich., Minn.

Chrysops obsoletus of authors, not Wiedemann, 1821, Dipt. Exot., I, p. 108. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:393. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 42 (♂). Daecke, 1906, Ent. News, **17**:38 (f); 1908, Ent. News, **18**:144 (f). Hine, 1907, La. Exp. Sta. Bull. No. 93, p. 32. Marchand, 1918, Trans. Amer. Ent. Soc., **44**:177 (f) . McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:197. Wehr, 1924, Nebr. Univ. Studies, **22**:112. Schwardt and Hall, 1930, Ark. Exp. Sta. Bull. No. 256, p. 13 (f).

Chrysops fraternus Kröber, 1926, Stettin Ent. Ztg., **87**:317 (f). Type, ♂, locality unknown; Vienna Nat. Mus.

68. *zinzala* Philip, 1942, Proc. N. Eng. Zool. Club, **21**:62. Type, ♀, Shippigan, N.B.; U.S.N.M. No. 56,361.

Chrysops lapponica Brennan, 1935, U. Kans. Sci. Bull., **22**:378. Not Loew, 1858, Verh. B. Ges. Wien, **8**:624.

NEOCHRYSOPS Walton, 1918,

Proc. Ent. Soc. Wash., **20**:191 (k). Brennan, 1935, U. Kans. Sci. Bull., **22**:350. Philip, 1941, Canad. Ent., **73**:9 (k). Genotype, *Neochrysops globosus* Walton, monotype.

1. *globosa* Walton, 1918, Proc. Ent. Soc. Wash., **20**:192 (f). Type, ♀, Cabin John Bridge, Md.; U.S.N.M. No. 22329. Brennan, 1935, U. Kans. Sci. Bull., **22**:350. Male unknown. Md.

Tribe MERYCOMYINI Philip, 1941,

Canad. Ent., **73**:4 (k).

MERYCOMYIA Hine, 1912,

Ohio Nat., **12**:515 (k, f). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 6. McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:191 (k). Hine, 1925, Occ. Pap. Mus. Zool. Univ. Mich. No. 162, p. 21 (k). Philip, 1941, Canad. Ent., **73**:4, 9 (k). Genotype, *Merycomyia geminata* Hine (=*M. whitneyi* (Johnson), orig. desig.

geminata Hine, equals *whitneyi*.

1. *mixta* Hine, 1912, Ohio Nat., **12**:516 (f). Type, ♀, Bainbridge, Ga.; Ohio S. U. Male unknown. Ga.

2. *whitneyi* (Johnson), 1904, Psyche, **11**:15 (*Tabanus*). Cotypes, ♀, ♂, Wellesley, Mass., and N. Y., respectively; B.S.N.H. and M.C.Z. No. 14523. Johnson, 1926, Occ. Pap. Boston Soc. Nat. Hist., VII, p. 104. Philip, 1942, Proc. N. Eng. Zool. Club, **21**:60. Mass., R.I., Conn., *Va., N.J., Ind.

Merycomyia geminata Hine, 1912, Ohio Nat., **12**:515 (f). Type, ♀, Lyme, Conn.; Ohio S. U. (Stone, 1938 states "lost," but seen by me in Jan., 1940).

Subfamily TABANINAE Loew, 1860,

Dipterenfauna Südafrika's, 14. Stone, 1938, U.S.D.A., Misc. Publ. No. 305, p. 172 (k, f). Philip, 1941, Canad. Ent., **73**:3, 5 (k); 1942, Proc. N. Eng. Zool. Club, **21**:55.

Section, OPISTANOPLAE Lutz, 1909, Zool. Jahrb. Sup. **10**:624; 1913, Brasil-Med., **27**(45):486. Enderlein, 1925, Mitt. Zool. Mus. Berlin, **10**(2):261 (k). Kröber, 1932, Rev. Ent., **2**:196 (k).

Tribe BOLBODIMYINI Philip, 1941,

Canad. Ent., **73**:5, 10 (k).

BOLBODIMYIA Bigot, 1892,

Wien. Ent. Ztg., **11**:162. Enderlein, 1925, Mitt. Mus. Zool. Berlin, **11**:341 (k). Kröber, 1929, Enc. Ent. Dipt., **5**:109 (k). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 10 (synonymy). Philip, 1941, Canad. Ent., **73**:5, 10 (k). Genotype, *Bolbodimyia bicolor* Bigot, orig. monotype.

Syn. *Snowiellus* Hine, 1904, Ohio Nat., 5:230; 1910, **10**:151 (f). Genotype, *S. atratus* Hine, orig. monotype.

1. *atrata* (Hine), 1904, Ohio Nat., **5**:230 (*Snowiellus*). Type, ♀, Oak Creek Canyon, Coconino Co., Ariz.; U. Kans. Stone, 1938, U.S.D.A. Misc. Publ. No. 306, p. 11 (f, synonymy). Male unknown. Ariz.

Snowiellus atratus Hine, 1910, Ohio Nat., **10**:151 (f).
stygius (Enderlein), 1925, equals *Whitneyomyia beatifica.*

Tribe DIACHLORINI End., 1922,

Mitt. Zool. Mus. Berlin, **10**:349 (k); 1925, 11: (k). Kröber, 1932, Rev. Ent., **2**:197 (k). Philip, 1941, Canad. Ent., **73**:5, 10 (k).

DIACHLORUS Osten Sacken, 1876,

Mem. Boston Soc. Nat. Hist., **2**:475 (change of name). Ricardo, 1904, Ann. Mag. Nat. Hist., ser. 7, **14**:356. Enderlein, 1922, Mitt. Zool. Mus. Berlin, **10**:349; 1925, **11**:336 (k). Kröber, 1928, Arch. Schiffs. u. Trop. Hyg., **32**(2):35 (k). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 12. Philip, 1941, Canad. Ent., **73**:5, 10 (k). Genotype, *Tabanus bicinctus* Fabricius, desig. Coquillett, 1910; not *T. ferrugatus* Fabricius, by Enderlein, 1922.

Syn. *Diabasis* Macquart, 1834, Hist. naturelle des Dipteres, I, p. 207. Genotype, *Tabanus bicinctus* Fabricius, desig. Coquillett, 1910. Not Hoffmansegg, 1817, Zoolog. Mag., **1**(1):44; not Desmarest, 1823, Prem. Decade Ichth., 30, p. 34.

Syn. *Dichlorus* MacCreary, 1940, Del. Exp. Sta. Bull. 226, p. 33 (lapsus).
ataenia (Macquart), equals *ferrugatus.*

1. *badius* Kröber, 1928, Arch. Schiffs-u. Trop. Hyg., **32**(2):50 (f). Type, ♀, Georgia; Vienna Nat. Mus. Stone, 1938, U.S.D.A. Mis. Publ. No. 305, p. 13. Philip, 1942, Proc. N. Eng. Zool. Club, **21**:60. Male unknown. Ga.?

2. *ferrugatus* (Fabricius), 1805, Syst. Antl., p. 111 (*Chrysops*). Type, ♀, "Carolina"; collection unknown. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:475 (synonymy); 1878, Smithsn. Misc. Collect. No. 270, p. 55; Biol. Centr.-Amer., Dipt., I, p. 57 (synonymy). Williston, 1901, Biol. Centr.-Amer., Dipt., I, p. 138. Ricardo, 1904, Ann. Mag. Nat. Hist., ser. 7, **14**:358 (synonymy). Banks, 1904, Ent. News, **15**:290. Lutz, 1907, Centralbl. Bakt. Paras., Abt. I, Orig., **44**:142. Bequaert, 1925, 13th Rep. United Fruit Co., Med. Dep. (1924), p. 205. Kröber, 1928, Arch. Schiffs-u. Trop. Hyg., **32**(2):36. Bequaert, 1931, Jour. N.Y. Ent. Soc., **39**:552 (f, synonymy). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p .13 (f). Male unknown. Del., N.J., N.C., *Ga., Fla., Ala., La., [West Indies and Mexico to Brazil].

Tabanus americanus Palisot de Beauvois, 1813-1820, Ins. Rec. en Afr. et en Amer., p. 222 (f). Type, ♀, United States; collection unknown. Not Forster, 1771, Novae Species Insec., centuria I, p. 100.

Tabanus ferrugatus. Wiedemann, 1821, Dipt. Exot., I, p. 94; 1828, Auss. zweifl. Ins., I, p. 186.

Diabasis ataenia Macquart, 1838, Dipt. exot. nouv. peu connus, I, pt. 1, p. 152

(partim) (orig. Mem., Lille, 1838, p. 156). Type, ♀, Carolina; Paris Museum? Walker, 1854, List, V, Sup. 1, p. 271.

Chrysops convergens Walker, 1848, List, I, p. 198. Type, ♀, Honduras; B.M.N.H. 1854, List, V, Sup. 1, 284.

Chrysops approximans Walker, 1848, List, I, p. 198. Type, ♀, Fla.; B.M.N.H.

Dichelacera ferrugata. Walker, 1848, List, I, 191; 1854, List, V, Sup. 1, p. 148.

Tabanus rondanii Bellardi, 1859, Saggio Ditter. Messicana, 1, p. 68 (f). Type, ♀, Mexico; probably Turin Mus.

Diabasis ferrugatus. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:396.

guttatulus Townsend, equals *Tabanus cribellum.*

haematopotides Bigot, equals *Galucops fratellus.*

STENOTABANUS Lutz, 1913,

Brasil-Medico, **27**:487; 1914, Mem. Inst. Oswaldo Cruz, **6**:167 (k). Enderlein, 1925, Mitt. Mus. Zool. Berlin, **11**:354 (k). Kröber, 1929, Enc. Ent., Dipt., **5**:113 (synonymy). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 31 (k, partim). Philip, 1941, Canad. Ent., **73**:5, 11 (k). Fairchild, 1942, Ann. Ent. Soc. Amer., **35**:297 (k, synonymy). Genotype, type, *Tabanus taeniotes* Wiedemann, by orig. desig.

Syn. *Styposelaga* Enderlein, 1922, Mitt. Mus. Zool. Berlin, **10**:348; 1925, **11**:342. Genotype, *Styposelaga sexannulata* Enderlein, by orig. desig.

daedalus Stone, see *Glaucops.*

1. *flavidus* (Hine), 1904, Ohio Nat., **5**:236. (*Tabanus*) Cotypes, unstated no. ♀♀, Ariz. and Sierra Madre, Chihuahua, Mex.; Ohio S. U. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 31 (f). Philip, 1941, Canad. Ent., **73**:105 (♂). Ariz., [Mexico].

AEGIALOMYIA Philip, 1941,

Canad. Ent., **73**:5, 10 (k). Fairchild, 1942, Ann. Ent. Soc. Amer., **35**:298 (subgenus). Genotype, *Tabanus psammophilus* Osten Sacken, by orig. desig.

1. *atlantica* (Johnson), 1913, Ann. Ent. Soc. Amer., **6**:445 (*Tabanus*, ♂). Cotypes, 2♀♀, Bermuda; M.C.Z. No. 7003. Philip, 1941, Canad. Ent. **73**:10. Bermuda Is.

Tabanus (*Stenotabanus*) *atlanticus* Bequaert, 1940, Rev. Entomologia, **11**:326 (f).

2. *magnicalla* (Stone), 1935, Proc. Ent. Soc. Wash., **37**:19 (*Tabanus*) (change of name). Philip, 1941, Canad. Ent., **73**:10. Tex.

Tabanus nanus Macquart, 1846, Dipt. nouv. peu connus, Sup. I, p. 42 (orig. Mem., Lille, 1846, p. 170). Type, ♂, Galveston, Texas; collection unknown. Not Wiedemann, 1821, Dipt. Exot., p. 95.

Tabanus maritimus Townsend, 1898, Ent. News, **9**:167. Cotypes, 3♂♂, Padre Island, Tex.; B.M.N.H. (now 1 headless specimen). Not Scopuli, 1763, Ent. Carniolica, p. 374.

Stenotabanus magnicallus. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 33 (f).

3. *psammophila* (Osten Sacken). 1876, Mem. Boston Soc. Nat. Hist., **2**:445. Cotypes, 4♂♂, 3♀♀, Ft. Capron, Fla. (lectotype, ♀, Stone, 1938); M.C.Z. No. 4040. Schwartz, 1916, Proc. Ent. Soc. Wash., **18**:210. Curran, 1931, Amer. Mus. Nov. No. 456, p. 4. Philip, 1941, Canad. Ent., **73**:10 (genotype sp.). Bequaert, 1940, Rev. Ent., **11**:325 (f). Fla.

Stenotabanus psammophilus Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 34 (f).

Tribe CHLOROTABANINI Philip, 1941,

Canad. Ent., **73**:5, 10 (k); 1942, Proc. N. Eng. Zool. Club, **21**:57.

CHLOROTABANUS Lutz, 1909,

Inst. Oswaldo Cruz em Manguinhos, p. 30; 1911, Internat'l Hyg. Ausstellung Dresden, p. 35; 1913, Brasil-Medico, **27**(45):487; 1914, Mem. Oswaldo Cruz, **6**:71. 167. Kröber, 1930, Zool. Anz., **87**:14; 1934, Rev. Ent., **4**:296. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 25. Philip, 1941, Canad. Ent., **73**:5, 10; Proc. N. Eng. Zool. Club, **41**:57. Genotype, *Tabanus mexicanus* Linnaeus, monotype.

Syn. *Ommalia* Enderlein, 1923, Deut. Ent. Zeit., p. 545; 1925, Mitt. Zool. Mus. Berlin, **11**:388. Genotype, *O. viridis* Enderlein (=*Tabanus inanis* Fabricius) by orig. desig.

Syn. *Stenotabanus* Enderlein, 1925, Mitt. Zool. Mus. Berlin, **11**:354 (partim); not Lutz, 1913, Brasil-Medico, **27**:487.

1. *crepuscularis* (Bequaert), 1926, Harvard Inst. Trop. Biol. Med., **4**:234 (*Tabanus*) (change of name). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 27 (f). Male, see "*mexicanus*" below. N.J., Md., Va., N.C., S.C., Ga., Fla., *Ala., La., Ark., Mo., Tex., Ariz.

Tabanus sulphureus Palisot de Beauvois, 1813-1820, Ins. rec. en Afr. et en Amer., p. 222 (partim). Type, ♀, "Saint Dominique, Etats-Unis d'Amerique"; collection unknown.

Tabanus flavus Macquart, 1834, Hist. Nat. Dipt., **1**:200. Type, ♀, United States; collection unknown. Knab, 1916, Insec. Insc. Menstr., **4**:98. Bequaert, 1924, Psyche, **31**:32. Not Wiedemann, 1828, Auss. zweifl. Ins., I, p. 163.

Tabanus mexicanus of authors, not Linnaeus, 1767, Syst. Nat., ed. 12, II, p. 1000. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:459 (partim, synonymy). Hine, 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 52 (♂, f, partim). Schwardt and Hall, 1930, Ark. Exp. Sta. Bull. No. 256, p. 26 (f).

Tribe CHRYSOZONINI Philip, 1941,

Canad. Ent., **73**:6 (k).

CHRYSOZONA Meigan, 1800,

Nouvelle class. mouches a deux ailes, p. 23. Bequaert, 1924, Psyche, **31**:26. Goffe, 1931, Trans. Ent. Soc. London, 1930, p. 60. Philip, 1941, Canad. Ent., **73**: 6, 10 (k). Genotype, *Tabanus pluvialus* Linnaeus, desig. Coquillett, 1910.

Syn. *Haematopota* Meigen, 1803, Illiger's Mag. f. Insektenkunde **2**:267; 1820, Syst. Beschr. der bekannten europ. zweifl. Insek., **2**:78. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:395 (k). Bigot, 1891, Bull. Soc. Fr., **16**:74 (k). Hine, 1903, Ohio State Acad. Sci., Spec. Pap. No. 5, p. 31 (k); 1904, Ohio Nat., **5**:231 (k). Johnson, 1912, Psyche, **19**:181-183 (k). Enderlein, 1925, Mitt. Zool. Mus. Berlin, **12**:397. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 79, 120-121 (k, klp). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 7 (k). Genotype, *Tabanus pluvialis* Fabricius, orig. monotype.

1. *americana* (Osten Sacken), 1875, Mem. Boston Soc. Nat. Hist., **2**:395 (*Haematopota*). Cotypes, "more than two dozen specimens" (lectotype, ♀, Hudson Bay Territory, Stone, 1938); M.C.Z. No. 4002. Williston, 1887, Kans. Acad. Sci., **10**:135. Hine, 1904, Ohio Nat., **5**:231. Johnson, 1912, Psyche, **19**:182. Cameron, 1926, Bull. Ent. Research, **17**:25 (lf, pf). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 96. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 8 (f, ♂). Alas., B.C., Alta., Sask., *Man., Ont., Minn., N.D., Mont., Ida., Wyo., Colo., *Utah, N.M., Calif.

2. *punctulata* (Macquart) 1838, Dipt. exot. nouv. peu connus, I, pt. 1, p. 163 (*Haematopota*) (orig. Mem., Lille, 1838, p. 167). Type, ♀, "Carolina"; possibly Paris Mus. Johnson, 1912, Psyche, **19**:182. Stone, 1938, U.S.D.A. Misc.

Publ. No. 305, p. 9 (f). Male unknown. Fla., "Carolina", Pa., N.J., R.I.

3. *rara* (Johnson), 1912, Psyche, **19**:182 (*Haematopota*). Type, ♀, Folsom, Delaware County, Pa.; M.C.Z. No. 7515. Champlain and Knull, 1923, Ent. News, **34**:211. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 10 (f). Male unknown. *N.J., Pa., Va.

Tribe TABANINI Enderlein, 1922,

Mitt. Zool. Mus. Berlin, **10**:346 (k). Philip, 1941, Canad. Ent., **73**:6, 10 (k).

GLAUCOPS Szilady, 1923,

Biol. Hung. Budapest, **1**:17 (f). Kröber, 1925, in Lindner, Die Fliegen der Palaeark. Reg., Lief. 8, 19, p. 54 (k); 1938, Acta Inst. Mus. Zool. Univ. Atheniensis, **2**:103 (k, subgenus). Philip, 1941, Canad. Ent., **73**:6 (k). Genotype, *Tabanus hirsutus* Villers, orig. monotype.

1. *daedalus* (Stone), 1938, U.S.D.A. Misc. Publ. No. 305, p. 32 (f, *Stenotabanus*). Type, ♀, Gainesville, Fla.; A.M.N.H. Philip, 1941, Canad. Ent., **73**:12 (♂). Fla., *Ga.

2. *fratellus* (Williston), 1887, Trans. Kans. Acad. Sci., **10**:140 (*Tabanus*). Cotypes, 2♀♀, Wash. Terr. (lectotype, Stone, 1938); Kan. U. Kröber, 1938. Acta Inst. Mus. Zool. Univ. Atheniensis, **2**:73 (? syn., *hirsutus* Vill.). Alas., B.C., Alta., Wash., Ore., Ida., *Mont.

Tabanus fratellus. Hine, 1904, Ohio Nat., **5**:237 (synonymy). Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:192 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 76 (f).

Diachlorus (?) *haematopotides* Bigot, 1892, Mem. Soc. Zool. Fr., **5**:22. Type, ♀, Wash. Terr.; B.M.N.H. Ricardo, 1900, Ann. Mag. Nat. Hist., ser. 7, **14**:357 (synonymy).

MICROTABANUS Fairchild, 1938,

Fla. Ent., **20**:10 (subgenus). Genotype, *Tabanus pygmaeus* Williston, monotype. "*Gen. nov.*" Williston, 1885, Ent. Amer., **1**:12. Philip, 1941, Canad, Ent., **73**:6, 10.

1. *pygmaeus* (Williston), 1887, Trans. Kans. Acad. Sci., **10**:141 (*Tabanus*). Type, ♀, Fla.; Kans. U. Male, see below. *N.Y., Del. Fla.

Atylotus pygmaeus. Stone, U.S.D.A. Misc. Publ. No. 305, p. 20 (f).
"*Gen. nov.*" Williston, 1885, Ent. Amer., **1**:12.
Tabanus pygmaeus. Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:194 (♂). Fairchild, 1938, Fla. Ent., **20**:10 (type, *Microtabanus* n. subgen.).

ATYLOTUS Osten Sacken, 1876,

Mem. Boston Soc. Hist., **2**:426 (subgenus). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 19 (k). Philip, 1941, Canad. Ent., **73**:11 (k); 1942, Proc. N. Eng. Zool. Club, **21**:56. Genotype, *Tabanus bicolor* Wiedemann, by desig. Hine, 1900, not orig. by Coquillett, 1910, as he states.

Syn. *Ochrops* Szilady, 1915, Ent. Mitt., **4**:93. Genotype, *Tabanus plebejus* Fallen, desig. by Enderlein, 1925.

Syn. *Dasystypia* Enderlein, 1922, Mitt. Zool. Mus. Berlin, **10**:347 (k, Genotype, *Tabanus rusticus* Linnaeus, by orig. desig.

acutus Bigot, see *Tabanus*.
baal Townsend, equals *Tabanus sagax*.

1. *bicolor* Wiedemann, 1821, Dipt. Exot., **1**:96. (*Tabanus*). Type, ♂, "No. Amer."; Vienna Nat. Mus. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:460

(♀, synonymy); 1878, Smithsn. Misc. Collect. No. 270, p. 62. Hine, 1900, Canad. Ent., **32**:247; 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 48. Stone, 1930, Ann. Ent. Soc. Amer., **23**:296 (l, p). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 103. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 62. Chagnon and Fournier, 1943, Nat. Canadien, **70**:76. Alta., Ont., Que., Me., Mass., N.Y., N.J., Del., Pa., D.C., Ill., Minn., Wis., *Mich., *N.D.

Tabanus fulvescens Walker, 1848, List, I, p. 171. Cotypes, 2♂♂, Mass. and "?"; B.M.N.H. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, pp. 62, 229 (synonymy).

Tabanus ruficeps Macquart, 1855, Dipt. exot. nouv. peu connus, Sup. V, p. 35 (orig. Mem., Lille, 1855, p. 55). Type, ♂, Baltimore, Md.; B.M.N.H. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 62.

2. *duplex* Walker, 1854, List V, Sup. I, p. 173 (change of name). Cameron, 1926, Bull. Ent. Research, **17**:26 (pf) (not Walker?). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 164 (unrecognized species).

Tabanus imitans Walker, 1848, List, I, p. 173. Cotypes, ♂, ♀, St. Martin's Falls, Albany River, Hudson's Bay, Can.; B.M.N.H. Not Walker, 1848, List, I, p. 146.

erythraeus Bigot, see *Tabanus*.

3. *incisuralis* (Macquart), 1847, Dipt. exot. nouv. peu connus, Sup. II, p. 21 (orig. Mem., Lille, 1847, p. 21) (*Tabanus*). Type, ♀, America; B.M.N.H. Philip, 1941, Canad. Ent., **73**:105 (synonymy). Alas., B.C., Alta., Sask., Mont., *Ida., Utah, Wyo., Colo., Calif., Ore., *Wash.

Tabanus intermedius Walker, 1848, List, I, p. 173. Cotypes, ♂, ♀, St. Martin's Falls, Albany River, Hudson's Bay, Can.; B.M.N.H. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 165 (unrecognized species). Philip, 1941, Canad. Ent., **73**:105 (synonymy).

Tabanus insuetus Osten Sacken, 1877, West. Dipt., p. 219. Cotypes 9♀♀ (lectotype ♀, Webber Lake, Calif.; Stone, 1938); M.C.Z. No. 14518. Hine, 1904, Ohio Nat., **5**:238. Webb and Wells, 1924, U.S.D.A., Dept. Bull. 1218, p. 26 (lf, pf, f). Cameron, 1926, Bull. Ent. Research, **17**:30 (lf, pf). Rowe and Knowlton, 1935, Canad. Ent., **67**:242 (f). Philip, 1936, Canad. Ent., **68**:158 (♂).

Atylotus insuetus. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 62. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 20 (f, synonymy).

3a. subsp. *tingaureus* (Philip), 1936, Canad. Ent., **68**:159 (*Tabanus*). Type, ♀, Libby, Mont.; Coll. Philip. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 20. (syn. of *insuetus*). Philip, 1941, Canad. Ent., **73**:105. Male unknown. Alas., Mont., Wash., *B.C.

3b. subsp. *utahensis* (Rowe and Knowlton), 1935, Canad. Ent., **67**:242 (f) (*Tabanus*). Type, ♀, Dolomite, Utah; U.S.N.M. No. 51331. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 20 (syn. of *insuetus*). Philip, 1941, Canad. Ent., **73**:105. Male unknown. Utah.

4. *ohioensis* (Hine), 1901, Canad. Ent., **33**:28 (*Tabanus*, change of name). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 53. Stone, 1903, U.S.D.A. Misc. Publ. No. 305, p. 22 (f). *Alta., Iowa, Minn., *Ill., Ind., Ohio, *Pa., N.Y., N.J.

Tabanus pruinosus Hine, 1900, Canad. Ent., **32**:248. Cotypes, 5♂♂, 3♀♀, Ohio; Ohio U. and U.S.N.M. No. 5339. Not Bigot, 1892, Mem. Soc. Zool. France, **5**:683.

5. *pemeticus* (Johnson), 1921, Boston Soc. Nat. Hist. Occ. Papers, **5**:11 (♂, *Tabanus*). Type, ♀, Southwest Harbor, Maine; B.S.N.H. Stone, 1938, U.S.D.A.

Misc. Publ. No. 305, p. 24 (f). Philip, 1942, Proc. N. Eng. Zool. Club, **21**:59. Chagnon and Fournier, 1943, Nat. Canadien, **70**:76. Minn., *Mich., Ind., *N.Y., Conn., Me., N.F., Que.

tenessensis Bigot, see *Tabanus molestus*.

6. *thoracicus* Hine, 1900, Canad. Ent., **32**:248 (*Tabanus*). Cotypes, 2♀♀, ♂, Oswego, N. Y., (lectotype, ♀, Stone, 1938); U.S.N.M. No. 5340. Stone 1938, U.S.D.A. Misc. Publ. No. 305, p. 24 (f, synonymy). Ont., *Que., Mont., *Minn., Wis., Pa., N.Y., Del.

ANACIMAS Enderlein, 1923,

Deut. Ent. Ztschr., p. 545; 1925, Mitt. Zool. Mus. Berlin, **11**:376 (k). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 28 (k). Philip 1941, Canad. Ent., **73**:11 (k). Genotype, *Anacimas limbellatus* Enderlein, 1925, by orig. desig.

1. *dodgei* (Whitney), 1879, Canad. Ent., **11**:37 (*Tabanus*). Cotypes, 9♀♀, Glencoe, Dodge Co., Nebr. (lectotype ♀, C.A.S., van Duzee, 1939). Neb., Kan., Okla.

Tabanus dodgei. Hine, 1904, Ohio Nat., **5**:236 (♂). Bequaert, 1933, Boston Soc. Nat. Hist. Occ. Pap., **8**:86. Philip, 1936, Ent. News, **47**:231 (synonymy). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 28 (f). van Duzee, 1939, Pan-Pac. Ent., **15**:116.

2. *geropogon* Philip, 1936, Ent. News, **47**:229 (♂, f). Type, ♀, Carolina (publ. "California") Beach, No. Car.; Coll. Philip. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 229 (f). N.C.

3. *limbellatus* Enderlein, 1923, Deut. Ent. Zeit., p. 545. Type, ♀, United States (prob. St. Johns Bluff, St. Johns River, Fla.); Berlin Mus. Enderelin, 1925, Mitt. Zool. Mus. Berlin, **11**:376. Philip, 1936, Ent. News, **57**:231. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 29 (f). Male unknown. Fla., *S.C.

AGKISTROCERUS Philip, 1941,

Canad. Ent., **73**:6, 13 (subgenus of *Dicladocera*, k); 1942, Proc. N. Eng. Zool. Club, **21**:57. Genotype, *Tabanus megerlei* Wiedemann, by orig desig.

1. *finitima* (Stone), 1938, U.S.D.A. Misc. Publ. No. 305, p. 15 (*Dicladocera*, f). Type, ♀, Jacksonville, Fla.; U.S.N.M. No. 51957. Philip, 1941, Canad. Ent. **73**:13. Male unknown. Fla.

2. *megerlei* (Wiedermann), 1828, Auss. zweifl. Ins., **1**:132 (*Tabanus*). Type, ♀, "Vaterland?"; Vienna Nat. Mus. Philip, 1941, Canad. Ent., **73**:12 (♂). N.C., Fla., Ala., La.

Tabanus megerlei. Osten Sacken, 1876, Mem. Boston. Soc. Nat. Hist., **2**:457. Williston, 1887, Trans. Kans. Acad. Sci., **10**:138. Hine, 1906, La. State Crop Pest Comm. Cir. 6, p. 38.

Tabanus megierlei Hine, 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 51 (lapsus).

Dicladocera megerlei. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 16 (f).

HAMATABANUS Philip, 1941,

Canad. Ent., **73**:6, 13 (k); 1942, Proc. N. Eng. Zool. Club, **21**:57. Genotype, *Tabanus scitus* Walker, by orig. desig.

Dicladocera Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 14 (partim, k). Not Lutz, 1909, Inst. Oswaldo Cruz em Manguinhos, p. 29.

1. *annularis* Hine, 1917, Ohio Jour. Sci., **17**:269 (♀ *Tabanus*). Type, ♂, Ocean Springs, Miss.; Ohio S. U. Miss.

Dicladocera annularis. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 17 (f).

2. *scitus* (Walker), 1848, List, I, p. 181. (*Tabanus*). Type, ♀, Ga.; B.M.N.H. Wis., Mich., Ill., Ky., Fla., Ohio, N.C., Ga., La.

Tabanus hirtioculatus Macquart, 1855, Dipt. exot. nouv. peu connus, Sup. V, p. 53 (orig. Mem., Lille, 1855, p. 33). Type, ♂, Baltimore, Md., B.M.N.H. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 277 (synonymy).

Tabanus cerastes Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:462. Cotypes, 3♀♀, Bee Spring, Ky., Wis.; M.C.Z. No. 4048. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 49.

Dicladocera scita. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 16 (♂, f, synonymy).

3. *sexfasciatus* (Stone), 1935, Proc. Ent. Soc. Wash., **37**:11 (*Dicladocera*). Type, ♀, Largo Key, Monroe Co. (publ. "Pinellas Co."), Fla.; Ohio S. U. Male unknown. Fla.

Dicladocera sexfasciata Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 18 (f).

LEUCOTABANUS Lutz, 1913,

Brasil-Med., **27**:487. Bequaert, 1931, J. N. Y. Ent. Soc., **39**:550. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 24 (k). Philip, 1941, Canad. Ent., **73**:11 (k). Fairchild, 1941, Ann. Ent. Soc. Amer., **34**:629 (k). Genotype, *Tabanus leucaspis* Wiedemann, desig. by Bequaert, 1924.

1. *ambiguus* Stone, U.S.D.A. Misc Publ. No. 305, p. 26. Type, ♀, Palmerlee, Ariz.; M.C.Z. No. 22406. Fairchild, 1941, Ann. Ent. Soc. Amer., **43**:636. Ariz., [Guatemala].

Tabanus albiscutellatus Hine, 1925, Mich. Univ. Mus. Zool. Occ. Pap., 162:34 (partim); not Macquart, 1850, Dipt. exot. nouv. peu connus, Sup. IV, pt. 1, p. 34 (orig. Mem., Lille, 1851, p. 338 (f)).

2. *annulatus* (Say), 1823, Jour. Acad. Nat. Sci. Philad., **3**:32. (*Tabanus*). Type, sex and no. unstated, Mo.; destroyed. Wiedemann, 1828, Auss. zweifl. Ins., **1**:185. Osten Sacken, 1878, Mem. Boston Soc. Nat. Hist., **2** (sup.):555. Hine, 1904, Ohio Nat., **5**:234; 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 43 (f). Jones and Bradley, 1923, Jour. Econ. Ent., **16**:310 (l). Schwardt and Hall, 1930, Ark. Agr. Exp. Sta. Bull. No. 256, p. 251. Schwardt, 1931, Jour. Kans. Ent. Soc., **4**:10 (l); 1936, Ark. Agr. Exp. Sta. Bull. No. 332, p. 26 (l). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 25 (f). Fairchild, 1941, Ann. Ent. Soc. Amer., **34**:637. Del., N.Y., N.C., Ga., Fla., La., Tex., Mo., Ark., Kan., Ky.

WHITNEYOMYIA Bequaert, 1933,

Boston Soc. Nat. Hist. Occ. Pap., **8**:84-85. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 11 (raises to genus, k). Philip, 1941, Canad. Ent., **73**:11 (k). Genotype, *Tabanus beatificus* Whitney, monotype.

1. *beatifica* (Whitney), 1914, Canad. Ent., **46**:353 (*Tabanus*). Type, ♀, Florida; M.C.Z. No. 17,057. Bequaert, 1933, Boston Soc. Nat. Hist. Occ. Pap., **8**:84. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 12 (f, ♂). N.C., S.C., Ga., Fla., La., *Tex.

Tabanus ater Palisot de Beauvois, 1812, Ins. rec. en Afr. et en Amer., p. 101 (f). Type, ♀, South Carolina; collection unknown. Not Rossi, 1790, Fauna Etrusca, 2, 320 (f); not Wiedemann, 1828, Auss. zweifl. Ins., 1, p. 186.

Tabanus lugubris Macquart, 1838, Dipt. exot. nouv. peu connus, I, pt. 1, p. 145 (orig. Mem., Lille, 1838, p. 149). Type, ♂, "Carolina"; Lille Mus.? Not Linnaeus, 1776, Fauna Suec., p. 464; not Zetterstedt, 1838, Ins. Lappon, Dipt., I, p. 515.

Snowiellus lugubris ("Osten Sacken"). Bequaert, 1924, Psyche, **31**:31 (lapsus).
Snowiellus stygius Enderlein, 1925, Mitt. Zool. Mus. Berlin, **11**:353.
stygius (Enderlein), equals *beatificus*.

HYBOMITRA Enderlein, 1922,

Mitt. Zool. Mus. Berlin, **10**:347 (k); **11**:253 (k). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 36 (syn, of *Tabanus*). Philip, 1941, Canad. Ent., **73**:7, 8, 11 (k, synonymy); 1942, Proc. N. Eng. Zool. Club, **21**:56. Fairchild, 1942, Ann. Ent. Soc. Amer., **35**:451 (subgenus). Genotype, *H. solox* Enderlein (=*Tabanus rhombicus* Osten Sacken), monotype.

Syn. *Therioplectes* of authors, not Zeller, 1842, Isis von Oken, p. 819.

Syn. *Therisplectes* Marten, 1882, Canad. Ent. **14**:210 (lapsus).

Syn. *Poecilosoma* Lutz, 1909, Inst. Oswaldo Cruz em Manguinhos, p. 29. Not Hübner, 1816, and others. Lutz, 1911, Int. Hyg. Ausst. Dresden, p. 33; 1913, Brasil-Med., **27**(45):6. Kröber, 1931, Zool. Anz., **94**:69. Genotype, *Tabanus quadripunctatus* Fabricius, desig. by Bequaert, 1924 (? for "*quadripunctatus* Macq." of Lutz).

?Syn. *Stypommia* Enderlein, 1922, Mitt. Zool. Mus. Berlin, **10**:346. Genotype, *S. patagonica* Enderlein, orig. desig.

Syn. *Dasyommia* Enderlein, ibid., p. 346. Genotype, *Tabanus cinctus* Fabricius, orig. desig.

Syn. *Tylostypia* Enderlein, ibid., p. 347. Genotype, *Tabanus astur* Erichson, orig. desig.

Syn. *Dasyphyrta* Enderlein, ibid., p. 344. Genotype, *Tabanus maculipennis* Macquart =*T. quadripunctatus* var. *amabilis* Walker, orig. desig.

Syn. *Hybopelma* Enderlein, ibid., p. 351. Genotype, *Tabanus quadripunctatus* Fabricius, orig. desig.

Syn. *Hypopelma* Enderlein, 1925, ibid., **11**:355 (lapsus), 409 (corrected).

Syn. *Tylostypina* Enderlein, 1923, Deut. Ent. Zschr., p. 545. Genotype *Lepiselaga tartarica* Portsch., orig. desig.

Syn. *Sipala* Enderlein, 1923, ibid., p. 545. Genotype, *Therioplectes acuminator* Lw., orig. desig.

Syn. *Sziladynus* Enderlein, 1925, Zool. Anz., **62**:181. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 37. Genotype, *Tabanus aterrimus* Meigen, orig. desig.

Syn. *Poecilochlamys* Lutz, 1922, Zool. Med., Sep. Folha Med., pp. 9 and 11; 1928, Estud. Zool. Parasit. Venezol., p. 57. Genotype, *Tabanus quadripunctatus* Fabricius, monotype.

Syn. *Poeciloderas* Borgmeier 1933, Rev. Ent., **3**:299. Lutz, 1921, Bol. Inst. Oswaldo Cruz, **1**:15 (nomen nudum). Kröber, 1932, Rev. Ent., **2**:199; 1934, Rev. Ent., **4**:297 (synonymy). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 37 (synonymy). Philip, 1941, Canad. Ent., **73**:7. Genotype, *T. quadripunctatus* Fabricius, orig. desig.

Syn. *Aplocera* Enderlein, 1933, Deut. Ent. Ztschr., p. 144. Genotype, *Therioplectes caucasica* End., orig. desig.

1. *aatos* Philip, 1941, Canad. Ent., **73**:148 (♂). Type, ♀, 10 mi. So. of Laramie, Wyo.; Coll. Philip. Wyo., Colo., N.M.

2. *aequetincta* (Becker), 1900, Act. Soc. Sci. Fennicae, **26**:8 (*Tabanus*). Cotypes, 3♀♀, Plakina and Kureika, N.W. Siberia; Helsinki U. Mus. No. 4027. Wis., Labr., [Holarctic].

Tabanus aequetinctus. Kröber, 1925, In Lindner, Die Fliegen der Palaear. Region Lfg. **6**:64 (synonymy). Stone, 1938, U.S.N.A. Misc. Publ. No. 305, p. 143 (f, synonymy). Male, see *flavipes* below.

Tabanus flavipes Wiedemann, 1828, Auss. zweifl. Ins., **1**:137. Type, ♀, Labrador; Copenhagen Mus. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:462 (♂). Not Gravenhorst, 1807, Vergl. Uebersicht Linn. u. einig. Neuern Zool. Syst., p. 363.

Therioplectes flavipes. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 56. Enderlein, 1925, Mitt. Zool. Mus. Berlin, **11**:358.

Tabanus nigrotuberculatus Fairchild, 1934, Occ. Pap. Boston Soc. Nat. Hist., **8**:139 (change of name).

3. *affinis* (Kirby), 1837, Fauna Bor.-Amer. **4**:313 (*Tabanus*). Type, sex?, Latitude 65°, Can.; collection unknown. Philip, 1942, Proc. N. Eng. Zool. Club, **21**:59. Alas., B.C., Alta., Sask., Man., *Ont., Que., N.F., *Me., Vt., *Mass., Conn., N.Y., N.J., Mich., *Wis., Minn., N.D., *S.D., Mont., Wyo., Colo., Ariz.

Tabanus affinis. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:466. Hine, 1904, Ohio Nat., **5**:234. McDunnough, 1921, Canad. Ent., **53**:141. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 102; 1937, Canad. Ent., **69**:36 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 137 (f). Not Megerlé von Mühlfeld, 1803, Appendix ad Catalogorum Insectorum, etc. [p. 18].

Therioplectes affinis. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 56. Enderlein, 1925 Mitt. Zool. Mus. Berlin, **11**:358.

Tabanus triligatus Walker, 1854, List, V, Sup. 1, p. 183, Type, ♀, Arctic America (labelled "Fort Simpson, Mackenzie River"); B.M.N.H.

4. *astuta* (Osten Sacken), 1876, Mem. Boston Soc. Nat. Hist., **2**:471 (*Tabanus*). Cotypes, 6♀♀ (lectotype, ♀, "White Mts.," N.H., Stone, 1938); M.C.Z. No. 4029. B.C., Alta., Sask., *Man., Ont., Que., Labr., Me., N.H., Mass., Conn., N.Y.?, N.J.?, Mich., Ill., Minn.

Tabanus astutus. Philip, 1936, Canad. Ent., **68**:153 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 146 (f). Chagnon and Fournier, 1943, Nat. Canad., **70**:80.

?*Tabanus comes* Walker, 1849, List, IV, p. 1152 (change of name). Philip, 1936, Canad. Ent., **68**:156. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 163 (unrecognized species).

?*Hybomitra comes*. Philip, 1941, Canad. Ent. **73**:149.

Tabanus inscitus Walker, 1848, List, I, p. 172. Cotypes, 2♀♀, St. Martin's Falls, Albany River, Hudson's Bay, Can.; B.M.N.H. (now missing). Not Walker, 1848, List, I, p. 161.

Therioplectes astutus. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 56.

5. *atrobasis* (McDunnough), 1921, Canad. Ent., **53**:144 (*Tabanus*). Type, ♀, Mount Lehman, B.C.; C.N.C. No. 210. B.C., Wash., Ore., Ida., Mont., *Wyo.

Tabanus atrobasis. Philip, 1937, Canad. Ent., **69**:35 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 159 (f).

6. *aurilimba* (Stone), 1938, U.S.D.A. Misc. Publ. No. 305, p. 130 (f) (*Tabanus*). Type, ♀, Paris, Me.; U.S.N.M. No. 51970. Philip, 1942, Proc. N. Eng. Zool Club, **21**:59. Male unknown. Me., Mass.

7. *boreus* (Stone), 1938, U.S.D.A. Misc. Publ. No. 305, p. 147 (f) (*Tabanus*). Type, ♀, Longitude 141°, latitude 69° 10′, Alaska; U.S.N.M. No. 51973. Male unknown. Alaska.

8. *brennani* (Stone), 1938, U.S.D.A. Misc. Publ. No. 305, p. 157 (f) (*Tabanus*). Type, ♀, Franconia, N. H.; A.M.N.H. Male unknown. Que., N. H.

9. *californica* (Marten), 1882, Canad. Ent., **14**:210 (*Tabanus*). Type, ♀, Calif.; destroyed. B.C., Wash., Ore., Calif., Mont. (?).

Tabanus californicus. McDunnough, 1921, Canad. Ent., **53**:141. Philip, 1935, Canad. Ent., **67**:95; 1937, **69**:37 (♂), 94. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 129 (f).

10. *captonis* (Marten), 1882, Canad. Ent., **14**:211 (*Tabanus*). Type, ♀, Calif.; destroyed. B.C., Wash., *Ore., Ida., Mont., Colo., Calif.

Tabanus captonis. Hine, 1904, Ohio Nat., **5**:235. McDunnough, 1921, Canad. Ent., **53**:141. Philip, 1935, Canad. Ent., **67**:95; 1937, **69**:37, 94 (redescribes ♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 139.

Tabanus recedens Walker, 1854, List, V, Sup. 1, p. 201. Type, ♀, "West Coast of America"; B.M.N.H. Not Walker, 1848, List I, p. 147.

Tabanus comastes Williston, 1887, Trans. Kans. Acad. Sci., **10**:137 (♂). Cotypes, 5♀♀, ♂, Wash. Terr. and Ht. Hood, Ore.; U. Kan.

11. *carolinensis* (Macquart), 1838, Dipt. exot. nouv. peu connus, I, pt. 1, p. 145 (*Tabanus*) (orig. Mem., Lille, 1838, p. 149). Cotypes, ♂, ♀, "Carolina"; Paris, Jardin des Plantes. *Vt., Mass., *R.I., N.Y., N.J., Pa., Del., Md., N.C., Ga., Okla., Ohio.

Tabanus carolinensis. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. **5**:49. Philip, 1937, Canad. Ent., **69**:37. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 126 (f).

Tabanus patulus Walker, 1848, List, I, p. 175. Cotypes, 3♀♀, ♂, Ga.; B.M.N.H.

Therioplectes carolinensis. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, pp. 56, 226.

12. *cincta* (Fabricius), 1794, Ent. Syst., **4**:366 (*Tabanus*). Type, ♀, Va.; U. Kiel Mus. (fragments). Man., Ont., Me., N.H., Conn., Mass., *R.I., N.Y., N.J., Ill., *Ohio, Pa., Del., Md., Va., N.C., S.C., Ga., *Miss., Tenn. [Mexico].

Tabanus cinctus. Wiedemann, 1821, Dipt. Exot., **1**:67. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:464 (♂). Philip, 1931, Minn. Exp. Sta. Tech. Bull. 80, p. 104. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 125 (f).

Dasyommia cincta. Enderlein, 1922, Mitt. Zool. Mus. Berlin, **10**:346, 1925, **11**: 349. Kröber, 1929, Zool. Anz., **83**:57. Genotype of *Dasyommia* Enderlein.

Therioplectes cinctus. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 56.

13. *criddlei* (Brooks), 1946, Canad. Ent., **77**:234 (Tabanus). Type, ♀, Aweme, Man.; C.N.C. No. 5629. Man., *Colo., *S.D., *N.D., *Minn., *Mich.

14. *daeckei* (Hine), 1917, Ohio Jour. Sci., **17**:269 (*Tabanus*). Type, ♀, Cape May, N.J.; Ohio S. U. Me., N.Y., N.J., Del., Va.

Tabanus daeckei. Philip, 1937, Canad. Ent., **69**:38 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 135 (f); 1940, Proc. Ent. Soc. Wash., **42**:62.

15. *epistates* (Osten Sacken), 1878, Mem. Boston Soc. Nat. Hist., **2** (sup.):555 (*Tabanus*, change of name). Alas., B.C., Alta., Sask., Man., *Ont., Que., Mich., N.H., Mass., N.Y., N.J., Ohio, *Ill., Wisc., Minn., Mont., *Colo., Utah, Ida., *Ore.

Tabanus epistates. Malloch, 1917, Bull. Ill. Lab. Nat. Hist., **12**:360. McDunnough, 1921, Canad. Ent., **53**:360. Philip, 1931, Minn. Agr. Exp. Sta. Tech. Bull. No. 80, pp. 105, 33 and 125 (p); 1937, Canad. Ent., **69**:39 (redescribes ♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 136 (f).

Tabanus socius Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:467. Cotypes, 14♀♀ (lectotype, Fort Simpson, Hudsons Bay Terr., Stone, 1938); M.C.Z. No. 4026, and Cole Coll. Not Walker, 1848, List, I, p. 160.

Therioplectes epistates. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 56.

Tabanus epistatus Hine, 1903, Ohio State Acad. Sci. Spec. Pap., **5**:50 (♂); 1904, Ohio Nat., **5**:236 (lapsus).

Tabanus californicus Hine, 1904, Ohio Nat., **5**:236; not Marten, 1882, Canad. Ent., **14**:210.

16. *frenchii* (Marten), 1883, Canad. Ent., **15**:111 (*Therioplectes*). Type, ♀, Montana; destroyed.

Tabanus frenchii. Philip, 1935, Canad. Ent., **67**:93; 1937, **69**:94. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 165 (unrecognized species).

17. *freta* (Stone), 1938, U.S.D.A. Misc. Publ. No. 305, p. 154 (♂, f) (*Tabanus*). Type, ♀, Lyme, Conn.; U.S.N.M. No. 51974. Conn., N.J.

18. *gracilipalpis* (Hine), 1923, Canad. Ent., **55**:143 (*Tabanus*). Type, ♀, Camp 334, near Fairbanks, Alas.; U.S.N.M. No. 26822. ?♂, see *cristatus*. Philip, 1941, Canad. Ent., **73**:150 (synonymy ?); 1942, Proc. N. Eng. Zool. Club, **21**:59. Alas., Alta.?, *Man.?, N.F.?, Minn.

Tabanus gracilipalpis. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. **80**:107; 1937, Canad. Ent., **69**:39. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 132 (f, synonymy).

?*Tabanus cristatus* Curran, 1927, Canad. Ent., **59**:81. Type, ♂, Nordegg, Alta.; C.N.C. No. 2369. Philip, 1937, Canad. Ent., **69**:37 (synonymy); 1941, Canad. Ent., **73**:150; 1942, Proc. N. Eng. Zool. Club, **21**:59.

19. *haemaphora* (Marten), 1882, Canad. Ent., **14**:210 (*Tabanus*). Cotypes, 2♀♀, California; destroyed. B.C., Man., Wash., Ore., Calif., Ida., Mont., *Wyo., Colo., Utah.

Tabanus haemaphorus. McDunnough, 1921, Canad. Ent., **53**:141. Philip, 1935, Canad. Ent., **67**:95; 1937, **69**:39 (♂), 94. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 137.

Tabanus haemophorus Aldrich, 1905, Smithsn. Misc. Coll., 46, No. 1444, p. 666 (lapsus) (syn. of *sonomensis*).

Tabanus haematophora Knowlton and Thatcher, 1934, Proc. Utah Acad. Sci., **11**:293 (lapsus).

20. *hearlei* (Philip), 1936, Canad. Ent., **68**:146 (*Tabanus*). Type, ♀, Fog. Horn Mt., Birch Island, B.C.; Coll. Philip. Male unknown. B.C., Man., *Que., Labr.

Tabanus hearlei. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 146 (f).

21. *hinei* (Johnson), 1904, Psyche **11**:15 (*Tabanus*, change of name, ♀). Ont., Mass., *R.I., *Conn., N.Y., N.J., Del., Pa., Va., N.C., Fla.

Tabanus hinei. Philip, 1937, Canad. Ent., **69**:39. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 124 (f).

Therioplectes politus Johnson, 1900, Ent. News, **11**:325; not Walker, 1871, The Entomologist, **5**:256. Type, ♂, Merchantville, N. J.; M.C.Z. No. 7521.

21a. subsp. *wrighti* (Whitney), 1915, Canad. Ent., **47**:380 (*Tabanus*). Type, ♀, West Palm Beach, Fla.; M.C.Z. No. 17061 (as *Tabanus wrighti*). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 125 (synonymy). Male unknown. N.C., Fla.

Tabanus wrighti. Bequaert, 1933. Occ. Pap. Boston Soc. Nat. Hist., **8**:87.

hirtula (Bigot), equals *tetrica* subsp.

22. *illota* (Osten Sacken), 1876, Mem. Boston Soc. Nat. Hist. **2**:469 (*Tabanus*). Cotypes, 12♀♀ (lectotype, ♀, Hudson's Bay Territory, Canada, Stone, 1938); M.C.Z. No. 4027. Alas., B.C., Alta., Sask., Man., Ont., Que., N.Y., Mich., Wis., Minn., Iowa., N.D., Mont., Wyo., Wash.

Tabanus illotus. Hine, 1904, Ohio Nat., **5**:238. Cameron, 1926, Bull. Ent. Re-

search, **17**:28 (pf). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 32, 107 (♂); 1937, Canad. Ent., **69**:39. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 150 (f). Chagnon and Fournier, 1943, Nat. Canadien, **70**:81.

Therioplectes illotus. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 56.

23. *itasca* (Philip), 1936, Canad. Ent., **68**:149 (*Tabanus*). Type, ♀, Itasca Park, Minn.; Minn. U. Male unknown. Minn.

Tabanus itasca. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 158 (f).

24. *labradorensis* (Enderlein), 1925, Mitt. Zool. Mus. Berlin, **11**:363 (*Tylostypia*). Type, ♀, Labrador; Berlin Mus. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 165 (unrecognized species).

25. *lanifera* (McDunnough), 1922, Canad. Ent., **54**:239 (*Tabanus*, ♂). Type, ♀, Banff, Alta.; C.N.C. No. 511. Alas., B.C., Alta., Wash., *Ore., Ida., Mont., Colo.

Tabanus laniferus. Philip, 1936, Canad. Ent., **68**:153. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 151 (f).

26. *lasiophthalma* (Macquart), 1838, Dipt. exot. nouv. peu pt., p. 143 (*Tabanus*) (orig. Mem., Lille, 1838, p. 147). Type, ♀, "Carolina"; collection unknown. N.S., Que., *Ont., *Man., Sask., Alat., Me., N.H., Vt., Mass., R.I., Conn., N.Y., N.J., Pa., Del., Md., D.C., Va., N.C., S.C., Ga.?, Fla.?, La., Ark., Ill., Ohio, Mich., Wis., Minn., *S.D., Colo., *Wyo., Mont., *Ida., *Wash.

Tabanus lasiophthalmus. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:465 (♂). Hine, 1903, Ohio State Acad. Sci. Spec. Pap., **5**:51; 1906, U.S.D.A., Bur. Ent .Tech. Ser., **12**:12 (lf, pf, f). Marchand, 1918, Trans. Amer. Ent. Soc., **44**:174 (f). Cameron, 1926, Bull. Ent. Research, **17**:31 (lf, pf). Philip, 1931, Minn. Exp. Sta. Tech. Bull., No. 80, pp. 13, 108 (ef, lf, pf); 1937, Canad. Ent., **69**:40. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 128 (F).

Tabanus punctipennis Macquart, 1847, Dipt. exot. nouv. peu connus, Sup. II, p. 23 (orig. Mem. Lille, 1847, p. 39). Cotypes, 2♀♀, Philadelphia, Pa.; B.M.N.H. Not Macquart, 1838, ibid., I, pt. 2, p. 185 (orig. Mem., Lille, 1839, pt. 3, p. 301, Brazil).

Tabanus notabilis Walker, 1848, List, I, p. 166. Cotypes, 3♀♀, "N.Y., Ga.?"; B.M.N.H. (two now present, the "GA.?" spec. marked type).

Tylostypia lasiophthalmus. Enderlein, 1925, Mitt. Zool. Mus. Berlin, **11**:363.

Therioplectes lasiophthalmus. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 56.

Therioplectus (sic) *lasiophthalmus*. Kröber, 1930, Zool. Anz., **86**:258.

27. *laticalla* (Philip), 1936, Canad. Ent., **68**:150 (*Tabanus*). Type, ♀, Greenbush, Minn.; Minn. U. Minn. Male unknown.

Tabanus laticallus. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 152 (f).

28. *laticornis* (Hine), 1904, Ohio Nat., **5**:239 (*Tabanus*). Cotypes, unstated no. ♂♂, ♀♀, Ariz. and N. Mex.; Ohio S. U. Ariz., N. Mex.

Tabanus laticornis. Philip, 1937, Pan.-Pac. Ent., **13**:66. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 57 (f).

laticornis (Enderlein), equals *tetricus* subsp. *rubrilatus*.

29. *liorhina* (Philip), 1936, Canad. Ent., **68**:151 (♂) (*Tabanus*). Type, ♀, Salmon Lake, Nicola Dist., B.C.; C.N.C. No. 3972. B.C., Alta., Man., Labr., N.S., Minn., Mich.?

Tabanus liorhinus. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 155 (f. ?*Tabanus rhombicus* Andrews, 1918, Occ. Pap. Mus. Zool. Univ. Mich. No. 53, p. 3; not (?) Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:472.

30. *longiglossa* (Philip), 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 144. Type, ♀, McGregor, Minn.; U. Minn. Male unknown. N.F., *Me., Mass., Minn.

Tabanus longiglossus. Fairchild, 1934, Occ. Pap. Boston Soc. Nat. Hist., **8**:143 (f). Philip, 1937, Canad. Ent., **69**:40. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 144 (f, ♂).

maculifer (Bigot) equals *sonomensis*.

31. *melanorhina* (Bigot), 1892, Mem. Soc. Zool. Fr., **5**:642 (*Therioplectes*?). Type, ♀, Wash. Terr.; B.M.N.H. Philip, 1941, Canad. Ent., **73**:150 (synonymy). B.C., Wash., Ore., Calif., Mont., Wyo., Colo., Utah.

Tabanus melanorhinus. Philip, 1936, Canad. Ent., **68**:155; 1937, **69**:49 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 156 (f).

Tabanus rhombicus (form 3) Osten Sacken, 1877, West. Dipt., p. 218.

32. *metabola* (McDunnough), 1922, Canad. Ent., **54**:239 (♂ *Tabanus*). Type, ♀, Nordogg, Alta.; C.N.C. No. 510. Alas., B.C., Alta., Sask., *Man., Ont., Que., Labr., N.Y., *Mich., Ill., Minn., Mont., Colo.

Tabanus metabolus. Hine, 1923, Canad. Ent., **55**:145. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 111; 1937, Canad. Ent., **69**:49. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 151 (f). Chagnon and Fournier, 1943, Nat. Canadien, **70**:80.

33. *microcephala* (Osten Sacken), 1876, Mem. Boston Soc. Nat. Hist., **2**:470 (*Tabanus*). Cotypes, 12♀♀, 3♂♂ (lectotype, ♀, White Mts., N.H.; Stone, 1938); M.C.Z. No. 4028. Ont., N.S., Labr., Me., N.H., Mass., N.Y., *Pa., N.J., Ohio, N.C., Mich., Minn.

Tabanus microcephalus. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 111; 1937, Canad. Ent., **69**:156. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 156 (f).

Therioplectes microcephalus. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 56.

34. *minuscula* (Hine), 1907, Ohio Nat., **8**:226 (*Tabanus*). Cotypes, unstated no. ♀♀, ♂, Orono, Me., Oswego, N. Y., Springfield, Mass., Ottawa, Ont.; Ohio S. U. Ont., Que., N.S., Me., Vt., Mass., N.Y.,W.Va., Minn., Wisc., *Mich.

Tabanus minusculus. McDunnough, Canad. Ent., **53**:142. Philip, 1937, Canad. Ent., **69**:50. Stone, 1930, Ann. Ent. Soc. Amer., **23**:297 (l, p); 1938, U.S.D.A. Misc. Publ. No. 305, p. 145 (f). Chagnon and Fournier, 1943, Nat. Canadien, **70**:81.

35. *nuda* (McDunnough), 1921, Canad. Ent., **53**:143 (*Tabanus*). Type, ♀, Ottawa, Can.; C.N.C. No. 208. Hine, 1923, Canad. Ent., **55**:144. Alas., B.C., Alta., Sask., Man., Ont., Que., N.B., Me., Mass., N.Y., Mich., Minn., Mont., Wyo.

Tabanus nudus. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 112; 1937, Canad. Ent., **69**:50 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 138 (f).

36. *oklahomensis* (Stone), 1933, Proc. Ent. Soc. Wash., **35**:76 (*Tabanus*). Type, ♀, Atoka, Okla.; U.S.N.M. No. 49377. Okla., *N.C., *S.C.

Tabanus oklahomensis. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 140 (f, ♂).

37. *opaca* (Coquillett), 1904, In Baker, Inv. Pac., **1**:21 (*Tabanus*). Cotypes, ♂, ♀, Ormsby County, Nev. (lectotype, ♀, Stone, 1938); U.S.N.M. No. 7319. Alta., Mont., Wyo., Colo., Utah, Nev. Calif.

Tabanus opacus. Hine, 1904, OhioNat., **5**:240 (♂). Philip, 1936, Canad. Ent., **68**:154; 1937, **69**:50. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 160 (f).

38. *philipi* (Stone), 1938, U.S.D.A. Misc. Publ. No. 305, p. 133 (f) (*Tabanus*). Type, ♀, Seattle, Wash.; A.M.N.H. Male unknown. Wash., Calif.

Tabanus philipi. Stone, 1940, Proc. Ent. Soc. Wash., **42**:61.

39. *procyon* (Osten Sacken), 1877, West. Dipt., p. 127 (*Tabanus*). Cotypes, 2♀♀, Sonoma Co., Calif.; M.C.Z. No. 14519. Sask.?, B.C., *Wash., *Ida., Mont., Wyo., Ore., Calif., N.M.?

Tabanus procyon. Hine, 1904, Ohio Nat., **5**:241. Cole and Lovett, 1921, Proc. Calif. Acad. Sci., ser. 4, **11**:234 (f). Philip, 1936, Canad. Ent., **68**:153 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 127.

Therioplectes procyon. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 57.

40. *rhombica* (Osten Sacken), 1876, Mem. Boston Soc. Nat. Hist., **2**:472 (*Tabanus*). Cotypes, 6♀♀, Colorado (lectotype, Stone, 1938); M.C.Z. No. 4030. B.C., *Sask., *Alta., *Mont., *S.D., *Wyo., Colo., Ariz., Utah, Ida., *Ore., ?Wisc., ?Ill.

Tabanus rhombicus. Osten Sacken, 1877, West. Dipt., p. 218. Hine, 1904, Ohio Nat., **5**:242. Cameron, 1926, Bull. Ent. Research, **17**:36 (pf). Rowe and Knowlton, 1935, Canad. Ent., **67**:243 (f). Philip, 1936, Canad. Ent., **68**:152. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 153 (f,? ♂, synonymy).

Therioplectes rhombicus. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 57.

Tabanus centron Marten, 1882, Canad. Ent., **14**:211. Type, ♀, Colorado; destroyed. Hine, 1904, Ohio Nat., **5**:235. Philip, 1935, Canad. Ent., **67**:94 (synonymy).

Hybomitra solox Enderlein, 1925, Mitt. Zool. Mus. Berlin, **11**:364. Type, ♀, Southern Colo.; Berlin Mus.

40a. subsp. *osburni* (Hine), 1904, Ohio Nat., **5**:241 (*Tabanus*). Cotypes, unstated no. ♀♀, ♂♂, "known from B.C., Alta., Mont., Wash. and Alaska"; Ohio S. U., M.C.Z., C.N.C., and Coll. Philip. Philip, 1941, Canad. Ent., **73**:150 (redescribes ♂). Alas., B.C., Alta., Sask., Minn., Mont., Ida., Wash., Ore., Utah, Wyo., Colo.

Tabanus osburni. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 114. Rowe and Knowlton, 1935, Canad. Ent., **67**:243. Philip, 1936, Canad. Ent., **68**:153 (synonymy). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 153 (synonymy).

41. *rupestris* (McDunnough), 1921, Canad. Ent., **53**:143 (*Tabanus*). Type, ♀, Gallatin County, Mont.; C.N.C. No. 209. B.C., Alta., Ida., Mont., S.D., Wyo., Colo., Utah, Ore.

Tabanus rupestris. Philip, 1936, Canad. Ent., **68**:50 (♂).

Tabanus rhombicus var. *rupestris*. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 154 (synonymy).

42. *septentrionalis* (Loew), 1858, Verh. Z. B. Ges. Wien, **8**:592 (*Tabanus*). Type, ♀, Labrador; probably Berlin Mus. Philip, 1941, Canad. Ent., **73**:151. Alas., B.C., Alta., Sask., Man., *Ont., Que., Labr., Me., Vt., Mass., N.Y., Mich., *Wis., N.D., *S.D., Neb., Colo., Wyo., Mont., *Ida.

Tabanus septentrionalis. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:467. Hine, 1904, Ohio Nat., **5**:243. Cameron, 1918, Agr. Gazette Canada, **5**:560.

Hine, 1923, Canad. Ent., **55**:145. Cameron, 1926, Bull. Ent. Research, 17:37 (lf, pf, ♂). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 115 (synonymy); 1937, Canad. Ent., **69**:53. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 162 (f, synonymy).

Therioplectes septentrionalis. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 56.

Tabanus canadensis Curran, 1927, Canad. Ent., **59**:82. Type, ♀, Winnipegosis, Manitoba; C.N.C. No. 2368.

Tylostypia septentrionalis. Enderlein (not Loew?), 1925, Mitt. Zool. Mus Berlin, **11**:363.

Stypommia septentrionalis. Enderlein, 1934, Sitzber. Gesell. Naturf. Freunde Berlin, **1934**:185.

42a. subsp. *frontalis* Walker, 1848, List, I, p. 172. Type, ♀, Nova Scotia, Cape Breton; B.M.N.H. (as *Tabanus frontalis*). Philip, 1941, Canad. Ent., **73**:151 (synonymy, ♂?). Alta., Sask., *Man., *Ont., *Que., N.S., *Ida., Mont., *Utah, Colo., *Wyo., *S.D., *N.D., *Minn., *Mich., N.Y.

Tabanus frontalis. Curran, 1927, Canad. Ent., **59**:82. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 161 (synonymy).

Tabanus incisus Walker, 1850, Ins. Saund., **1**:26. Type, ♀, Nova Scotia; B.M.N.H.

43. *sexfasciata* (Hine), 1923, Canad. Ent., **55**:144 (*Tabanus*). Type, ♀, Camp 334, near Fairbanks, Alas.; U.S.N.M. No. 26823. Alas., Labr., [Holarctic].

Tabanus sexfasciatus. Stone, 1935, Proc. Ent. Soc. Wash., **37**:18 (synonymy); 1938, U.S.D.A. Misc. Publ. No. 305, p. 141 (f, ♂).

Tabanus borealis of authors (not Fabricius).

solox Enderlein, equals *Hybomitra rhombicus.*

44. *sonomensis* (Osten Sacken), 1877 West. Dipt., p. 216 (*Tabanus*). Cotypes, 11♀♀, Sonoma Co., Calif. (lectotype, Stone, 1938); M.C.Z. No. 14520. B.C., Alta., *Sask., Alas., Mont., N.D., S.D., Wyo., Colo., Utah, Ida., Calif., Ore., Wash., Ariz., ?N. Mex.

Tabanus sonomensis. Hine, 1904, Ohio Nat., **5**:244 (♂). McDunnough, 1921, Canad. Ent., **53**:143. Philip, 1937, Canad. Ent., **69**:51 (♂, synonymy). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 133 (f, synonymy).

Therioplectes sonomensis. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 57.

Therioplectes maculifer Bigot, 1892, Mem. Soc. Zool. France, **5**:641. Type, ♀, Wash. Terr.; B.M.N.H. Philip, 1941, Canad. Ent. :

Tabanus sonemensis Rowe and Knowlton, 1935, Canad. Ent., **67**:244 (lapsus).

44a. subsp. *phaenops* Osten Sacken, 1877, West. Dipt., p. 217 (as *Tabanus phaenops*). Cotypes 4♀♀, "Webber Lake," Sierra County, Calif. (lectotype, Stone, 1938); M.C.Z. No. 14521. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 134 (synonymy). *B.C., *Wash., Ore., Ida., Mont., *Wyo., Utah, Calif.

Tabanus phaenops. Hine, 1904, Ohio Nat., **5**:241. McDunnough, 1921, Canad. Ent., **53**:143. Webb and Wells, 1924, U.S.D.A., Dep. Bull. No. 1218, p. 20 (lf, pf, ef, f, ♂). Cameron, 1926, Bull. Ent. Research, **17**:33 (lf, pf). Rowe and Knowlton, 1935, Canad. Ent., **67**:243.

Therioplectes phaenops. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 57.

Tabanus phoenops Surcouf, 1921, Gen. Ins., Fasc. 175, p. 79 (lapsus).

45. *susurra* (Marten), 1883, Canad. Ent., **15**:111 (*Therioplectes*). Type, ♀, Montana; destroyed. Philip, 1935, Canad. Ent., **67**:94. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 167 (unrecognized species).

46. *tetrica* (Marten), 1883, Canad. Ent., **15**:111 (*Therioplectes*). Type, ♀, "from Montana"; destroyed. Philip, 1941, Canad. Ent., **73**:151. Alta., Mont., Wyo., Colo., Utah, *Nev., Calif.

Tabanus rhombicus Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:472 (partim, 1 ♀ cotype).

Tabanus centror Knowlton and Thatcher, 1934, Proc. Utah Acad. Sci., **11**:293 (lapsus).

Tabanus centron Rowe and Knowlton, 1935, Canad. Ent., **67**:241; not Marten, 1882, Canad. Ent., **14**:211.

Tabanus tetricus. Philip, 1935, Canad. Ent., **67**:93 (synonymy); 1937, **69**:94; 1937, Pan.-Pac. Ent., **13**:64 (synonymy).

46a. subsp. *hirtula* (Bigot), 1892, Mem. Soc. Zool. Fr., **5**:641 (as *Therioplectes hirtulus*). Type, ♀, Wash. Terr.; B.M.N.H. Philip, 1941, Canad. Ent., **73**:151 (synonymy). B.C., Alta., Sask., Man., Ont., *S.D., Mont., Ida., Utah, Wyo., Colo., N.M., *Nev., Calif., Ore., Wash., Ill.?

Tabanus hirtulus. Hadwen, 1914, Proc. Brit. Col. Ent. Soc., **4**(n.s.):48. Cameron, 1926, Bull. Ent. Research, **17**:27 (lf, pf). Rowe and Knowlton, 1936, Canad. Ent., **67**:242 (f). Philip, 1936, Canad. Ent., **68**:155 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 159 (f).

Tabanus frenchii Hine, 1904, Ohio Nat. **5**:237; not Marten, 1883, Canad. Ent., **15**:111.

Tabanus opacus Hine, 1904, Ohio Nat. **5**:240. Cole and Lovett, 1921, Proc. Calif. Acad. Sci., **11**:234. Not Coquillett, 1904, In Baker, Inv. Pac., **1**:21.

46b. subsp. *rubrilatus* (Philip), 1937, Pan-Pac. Ent., **13**:64 (♂, *Tabanus*). Type, ♀, southern Colo.; Coll. Philip. Philip, 1941, Canad. Ent., **73**:151 (synonymy).

Tylostypia laticornis Enderlein, 1925, Mitt. Mus. Zool. Berlin, **11**:363. not "*Tabanus*" *laticornis* Hine, 1904, Ohio Nat., **5**:239. Type, ♀, So. Colo.; Berlin Mus. Stone, 1938 U.S.D.A. Misc. Publ. No. 305, p. 165 (unrecognized species).

47. *trepida* (McDunnough), 1921, Canad. Ent., **53**:142 (*Tabanus*). Type, ♀, Ottawa, Ont.; C.N.C. No. 206. *Alas., B.C., Alta., Man., Ont., Que., N.S., N.B., Me., *Mass., N.Y., N.J., Pa., *Mich., Wis., Minn., *Mont., *Ida.

Tabanus trepidus. Stone, 1930, Ann. Ent. Soc. Amer., **23**:301 (l, p). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 117. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 131 (f). Philip, 1937, Canad. Ent. **69**:51 (♂).

48. *trispila* (Wiedemann), 1828, Auss. zweifl. Ins., **1**:150 (*Tabanus*). Type, ♂, Ky.; Vienna Nat. Mus. *Ont., Que., Me., Vt., N.H., Mass., Conn., *R.I., N.Y., Mich., Wisc., Minn., Ill., Pa., N.J., Del., Md., Va., N.C., Ga. [Mexico].

Tabanus trispilus. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:464 ♀. Surcouf, 1921, Gen. Ins., Fasc. 175, p. 87 (synonymy). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 34, 118 (l, pf). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 149 (f). Chagnon and Fournier, 1943, Nat. Canadien, **70**:51 (f).

Tabanus sodalis, Williston, Trans. Kans. Acad. Sci., **10**:139. Cotypes not stated (3 ♀ ♀, "White Mts." N.H. and Conn."); Kans. U.

Therioplectes trispilus. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 56.

49. *typha* (Whitney), 1904, Canad. Ent., **36**:206 (*Tabanus*). Cotypes, ♀ ♀, Milford, N.H. (lectotype, Stone, 1938); M.C.Z. No. 17060. B.C., Alta., Sask., Ont., Que., N.B., Mont., Minn., *Mich., N.H., Mass., N.Y., *Pa., N.J., Md.

Tabanus typhus. Bequaert, 1933, Boston Soc. Nat. Hist. Occas. Pap., **8**:87. Philip, 1936, Canad. Ent., **68**:154 (♂, p). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 148 (f).

Tabanus astutus Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:471 (partim).

50. ?*vicina* (Macquart), 1838, Dipt. exot. nouv. peu connus, I, pt. 1, p. 143 (orig. Mem., Lille, 1838, p. 147) (*Tabanus*). Type, ♀, "Carolina"; collection unknown, orig. Coll. Serville. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 167 (Unrecognized species). Philip,1941, Canad. Ent., **73**:152 (?synonymy).

51. *zonalis* (Kirby), 1837, Fauna Bor-Amer., **4**:314 (*Tabanus*). Type, sex ?, Latitude 65°, Can.; collection unknown. No. West Terr., B.C., Alta., *Sask., *Man., Que., *Labr., N.B., N.S., N.F., Wash., Minn., Wis., Mich., Me., *N.H., Mass., Conn., N.Y., N.J., Pa.

Tabanus zonalis. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:463. Hine, 1904, Ohio Nat., **5**:244. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 118. Fairchild, 1934, Boston Soc. Nat. Hist. Occ. Pap., **8**:139. Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:196 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 142 (f). Chagnon and Fournier, 1943, Nat. Canadien, **70**:79.

Therioplectes zonalis. Osten Sacken, Smithsn. Misc. Collect. No. 270, pp. 56, 226 (synonymy). Townsend, 1895, Trans. Amer. Ent. Soc., **22**:58.

Tabanus tarandi Walker, 1848, List, I, p. 156. Cotypes, 2♀♀, Hudson's Bay Terr.; collection unknown.

Tabanus terrae-novae Macquart, 1849, Dipt. nouv. peu connus, Sup, IV, pt. 1, p. 35 (orig. Mem., Lille, 1850, p. 339). Cotypes, 4♀♀, "de Terre-Neuve"; B.M.N.H.

Tabanus flavocinctus Bellardi, 1859, Saggio ditter. messicana, **1**:61. Type, ♀, "Mejico (?)"; probably Turin Mus.

52. *zygota* (Philip), 1937, Canad. Ent., **69**:52 (♂, *Tabanus*). Type, ♀, Crater Lake, Ore.; C.A.S. No. 4509. Philip, 1941, Canad. Ent., **73**:152 (k). Ore.
Tabanus zygotus. Philip, 1937, Canad. Ent., **69**:267 (correction).

TABANUS Linnaeus, 1758,

Systema Naturae, ed. 10, I, 601. Osten Sacken, 1875, Mem. Boston Soc. Nat. Hist., **2**:421-479 (k); 1878, 2(sup.): 555-560. Willison, 1886, Trans. Kans. Acad. Sci., **10**:135-142 (k). Hine, 1903, Ohio State Acad. Sci. Spec. Pap., **5**: 46-57 (k, Ohio and N.E. spp.); 1904, Ohio Nat., **5**:231-245 (k, w, spp.); 1906, Ohio Nat., **7**:19-30 (k, *lineola* group); 1907, La. Agr. Exp. Sta. Bull. 93, pp. 37-59 (k, S. spp.). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:198-205 (k, E. spp.). McDunnough, 1921, Canad. Ent., **53**:139-144 (k, *affinis* group). Schwardt and Hall, 1930, Ark. Agr. Exp. Sta. Bull. No. 256, pp. 15-26 (k, S. spp.). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 96-119, 13-34 (lk, pk, k; N. spp.). Johannsen, 1935, Cornell Exp. Sta. Mem. 177 (II), p. 15 (lfk, pfk). Philip, 1936, Ohio Jour. Sci., **36**:149-156 (k, *longus* group, synonymy); 1936, Canad. Ent., **68**:148-160 (k, *rhombicus* group, synonymy); 1936, Canad. Ent., **69**:35-40, 49-58 (k, *affinis* group, synonymy). Schwardt, 1936, Ark. Agr. Exp. Sta. Bull. No. 332, pp. 27-58 (S. spp.). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, 171 pp. (k, f, monograph, synonymy). Bequaert, 1940, Rev. Ent., **11**:289 (synonymy). Philip, 1941, Canad. Ent., **73**:11 (k); 1942, Psyche, **49**:25 (k, *lineola* group). Genotype, *Tabanus bovinus* Linnaeus, desig. by Latreille, 1810.

Syn. *Tabamus* Rondani, 1864, Dipt. Exot. Modena, p. 78 (lapsus).

Syn. *Neotabanus* Lutz, 1909, Inst. Oswaldo Cruz em Manguinhos, p. 29. Genotype, *Tabanus trilineatus* Latreille, desig. by Bequaert, 1924. Kröber, 1933, Rev. **35**:153 (k). Fairchild, 1942, Ann. Ent. Soc. Amer., **35**:153 (k).

Syn. *Tanabus* Mosier and Snyder, 1918, Proc. Ent. Soc. Wash., **20**:125 (lapsus).

Syn. *Straba* Enderlein, 1923, Deut. Ent. Zeitschr., **1923**:545. Stone, 1938, U.S.-D.A. Misc. Publ. No. 305, p. 37 (synonymy). Genotype, *Tabanus sudeticus* Zeller, orig. desig.

?Syn. *Hybostraba* Enderlein, 1923, Deut. Ent. Zeit., p. 545; 1925, Mitt. Zool. Mus. Berlin, **11**:356. Kröber, 1931, Zool. Anz. **94**:69. Genotype, *Hybostraba guttiventris* Enderlein by orig. desig.

Syn. *Taeniotabanus* Kröber, 1930, Diptera of Patagonia and South Chile, pt. 5, p. 140 (nomen nudum); 1931, Zool. Anz., **94**:69; 1932, Rev. Ent., **2**:201. Genotype, *Tabanus occidentalis* Linnaeus, desig. by Borgmeier, 1933.

1. *aar* Philip, 1941, Canad. Ent., **73**:105 (♂). Type, ♀, State College, Miss.; Coll. Philip. Ga., Fla., Miss.

?*Tabanus catenatus* "var.?", Walker, 1854, List V, Sup. 1, p. 172. Osten Sacken, 1878, Smithsn. Misc. Collect. 270, p. 227 (partim). Philip, 1941, Canad. Ent., **73**:107 (synonymy).

Tabanus turbidus of authors (partim), not Wiedemann, 1828, Auss. zweifl. Ins., **1**:124. Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:195 (♂ misidentification). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 112.

2. *abactor* Philip, 1936, Ohio Jour. Sci., **36**:153 (♂). Type, ♀, Eastland Co., Tex.; Coll. Philip. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 69 (k). Kan., Okla., *Ark., Tex.

Tabanus gracilis Sanborn, Stiles, and Moe, 1932, Okla, Agr. Expt. Sta. Bull. 204. Not Wiedemann, 1828, Auss. zweifl. Ins., **1**:156.

3. *abditus* Philip, 1941, Canad. Ent., **73**:142. Type, ♀, Oak Creek Canyon, Ariz.; C.A.S. No. 5147. Male unknown. Ariz.

4. *abdominalis* Fabricius, 1805, Syst. Antl., p. 96. Cotypes, 2♀♀, Carolina; U. Kiel Zool. Mus. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:434; 1878, (sup.): 557; 1878, Smithsn. Misc. Collect. No. 270, p. 227. McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:204. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 116 (f). Male unknown. *Mass., Conn., Pa., N.J., D.C., Fla., Ga., Miss., La., Tex., Ark., Okla., Ky., *Mich., Ind., Ill., Kan., Neb. (Note: Macquart's Guiana record is probably mistaken identification.)

5. *actaeon* Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:443. Cotypes, 7♀♀ (lectotype, ♀, Mass., Stone, 1938); M.C.Z. No. 4036. McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:201. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 101 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 103 (f). Chagnon and Fournier, 1943, Nat. Canadien, **70**:77. Que., N.S., Conn., Mass., N.Y., Del., Md., D.C., N.C., *Mich., Minn., Wis.

Tabanus novae-scoeiae Macquart, 1847, Dipt. exot. nouv. peu connus, Supt. 2, p. 24 (orig. Mem., Lille, 1847, p. 40). Type, ♀, Nova Scotia; B.M.N.H. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 166. Philip, 1941, Canad. Ent., **73**:108 (synonymy).

6. *acutus* (Bigot), 1892, Mem. Soc. Zool. Fr., **5**:660 (*Atylotus*). Type, ♀, North America (New Orleans); B.M.N.H. Hine, 1906, Ohio Nat., **7**:22 (♂, synonymy); 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 40 (f). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 217 (f). So. La., Fla., *Ga.

7. *aegrotus* Osten Sacken, 1877, West. Dipt., p. 219. Type, ♀, Napa Co., "Calif."; M.C.Z. No. 14,522. Williston, 1887, Trans. Kans. Acad. Sci., **10**:139. Hine, 1904, Ohio Nat., **5**:234. Rowe and Knowlton, 1935, Canad. Ent., **67**:240. Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:190 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 90 (f). B.C., Wash., *Ida., *Mont., Utah, *Ore., Calif.

aequalis Jones and Bradley (lapsus), equals *equalis.*
aequetinctus Becker, see *Hybomitra.*
affinis Howard (not Kirby), equals *Hybomitra californica.*
affinis Kirby, see *Hybomitra.*
albiscutellatus Hine (not Macquart), equals *Leucotabanus ambiguus.*
allynii Marten, equals (?) *nigrovittatus.*

8. *americanus* Forster, 1771, Novae Species Insec., centuria I, p. 100. Type, ♀, Va., and "Provincia Noveboracensi, Americae Septentrionalis"; collection unknown. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:457 (synonymy, ♂). Hine, 1907, La. Agr. Exp. Sta. Bull. No. **93**:42 (f). Mosier and Snyder, 1918, Proc. Ent. Soc. Wash., **20**:120 (eye colors, ♂). Schwardt and Hall, 1930, Ark. Agr. Exp. Sta. Bull. No. 256, p. 22. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 83 (f). Mass., *Conn., N.Y., N.J., Del., Pa., Md., Va., B.C., *Ga., Fla., Mich., Ill., *Neb., Ky., Mo., Ark., La.

Tabanus plumbeus Drury, 1773, In Index to Pt. I, Illus. Nat. Hist., publ. with Pt. II; 1770, [descr. without name] Pt. I, p. 103 (f). Type, ♀, New York, Va.; collection unknown.

Tabanus ruficornis Fabricius, 1775, Syst. Ent., p. 789. Cotypes, unstated no. ♀♀, America; Kiel Zool. Mus. (fragments and 1 whole spec.).

Tabanus limbatus Palisot de Beauvois, 1807, Ins. rec. en Afrique et en Amer., p. 54. Type, ♀, United States; collection unknown.

Stigmatophthalmus americanus. Enderlein, 1925, Mitt. Zool. Mus. Berlin, **11**:387.

Tabanus americus Mosier and Snyder, 1918, Proc. Ent. Soc. Wash., **20**:119 (lapsus).

americanus Drury (not Forster), equals *atratus.*

americanus Palisot de Beauvois (not Forster, not Drury), equals *Diachlorus ferrugatus.*

americus Mosier and Snyder (lapsus), equals *americanus.*

9. *amplifrons* Kröber, 1933, Rev. Ent., **3**:354. Type, ♀, Maracay, Venezuela; Münich. Philip, 1942, Psyche, **99**:34 (♂). Fairchild, 1942, Ann. Ent .Soc Amer., **35**:178 (f). Tex.

annularis Hine, see *Hamatabanus.*
annulatus Say, see *Leucotabanus.*
arborealis Stone, equals *vivax.*
astutus Osten Sacken, see *Hybomitra.*
astutus Osten Sacken (partim), equals *Hybomitra typha.*
ater Palisot de Beauvois (not Rossi, not Wiedemann), equals *Whitneyomyia beatifica.*
ater Wiedemann (not Rossi, not Palisot de Beauvois), equals *Tabanus wiedemanni*
atlanticus Johnson, see *Aegialomyia.*

10. *atratus* Fabricius, 1775, Syst. Ent., p. 789. Cotypes 2♀♀, America; U. Kiel Zool. Mus. (fragments). Wiedemann, 1828, Auss. zweifl. Ins., **1**:114. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:454 (synonymy, ♂). Hart, 1895, Ill. Lab. Nat. Hist. Bull., **4**:242 (ef, lf, pf). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. **5**:48; 1906, U.S.D.A. Bur. Ent. Tech. Ser. **12**:34 (pf, f); 1906, La. State Crop Pest Comm. Cir. **6**:15 (ef); 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 44 (f). Garman, 1910, Ky. Agr. Exp. Sta. Bull. No. 151, 182 (ef, lf, f). Daecke, 1910, Ann. Rep. N.J. State Mus., p. 742 (lf, pf). Malloch, 1917, Bull. Ill. Lab. Nat Hist., **12**:359 (lf, pf). Johnson, 1919, Psyche, **26**:163. Davis, 1919, Ill. Nat. Hist. Survey Bull. **13**:97 (f). Wehr, 1922, U Nebr. Studies, **22**:10. Bromley, 1926, Ann. Ent. Soc. Amer., **19**:440 (f). Stone, 1930, Ann. Ent. Soc. Amer., **23**:294 (lp). Schwardt, 1930, Ark. Agr. Exp. Sta. Bull. No. 256, p. 21 (f). Philip, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 103, 123 (l), 124 (p). Kröber, 1934, Rev. Ent., **4**:306. Rowe and

Knowlton, 1935, Canad. Ent., **67**:241. Schwardt, 1936, Ark. Agr. Exp. Sta. Bull. No. **332**:27 (ef). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 87 (f). Que., Ont., Mass., N.Y., N.J., Pa., Del., Md., D.C., Va., N.C., Ga., Fla., *Miss., La., Tex., *Okla., Ark., *Mo., *Tenn., *Ky., Ohio, *Mich., Ind., Ill., *Iowa, Wis., Minn., *N.D., S.D., Neb. Kan., *Colo., *Wyo., *Mont., Ida., Utah, N.M. [Mexico].

Tabanus americanus Drury, 1773, *In* Index to Pt. I, Illus. Nat. Hist., publ. with Pt. II; 1770, [descr. without name] Pt. I, p. 104. Type, ♀, New York; collection unknown. Not Forster, 1771, Nov. Sp. Ins., cent. I, p. 100.

Tabanus niger Palisot de Beauvois, 1897, Ins. rec. en Afr. et en Amer., p. 54. Type, ♀, Pennsylvania; collection unknown.

Tabanus validus Wiedemann, 1828, Auss. zweifl. Ins., **1**:113. Cotypes, 2♀♀, Philadelphia, Pa.; U. Kiel Zool. Mus. (fragments).

Straba atrata. Enderlein, 1935, Mitt. Zool. Mus. Berlin, **11**:355.

Stigmatophthalmus atratus. Enderlein, 1925, Mitt. Zool. Mus. Berlin, **11**:387.

10a. subsp. *fulvopilosus* Johnson, 1919, Psyche, **26**:164. Cotypes, unstated no. and sex, (lectotype, ♀, Orlando, Fla., Stone, 1938); M.C.Z. No. 7509. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 89. Male unknown? Mass., Del., N.C., S.C., *Ga., Fla.

10b. subsp. *nantuckensis* Hine, 1917, Ohio Jour. Sci., **17**:271 (♂). Type, ♀, Nantucket Island, Mass.; Ohio S. U. Johnson, 1919, Psyche, **26**:163 (synonymy). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 89. N.H., Mass., N.Y.

atripennis Stone, equals *nigrescens* subsp.

atrobasis McDunnough, see *Hybomitra.*

aurilimbus Stone, see *Hybomitra.*

baltimorensis Macquart, equals *quinquevittatus.*

beatificus Whitney, see *Whitneyomyia.*

benedictus Whitney, equals *proximus.*

bicolor Macquart (not Wiedemann), equals *giganteus.*

bicolor Wiedemann, see *Atylotus.*

11. *birdei* Whitney, 1914, Canad. Ent., **46**:343. Cotypes, 9♀♀, West Palm Beach, Fla.; M.C.Z. No. 17059. Bequaert, 1933, Boston Soc. Nat. Hist. Occ. Pap., **8**:86. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 80 (f). Male unknown. Fla.

12. *bishoppi* Stone, 1933, Proc. Ent. Soc. Wash., **35**:77. Type, ♀, Silver Springs, Fla.; U.S.N.M. No. 49378. Stone, 1935, Proc. Ent. Soc. Wash., **37**:16 (♂); 1938, U.S.D.A. Misc. Publ. No. 305, p. 53 (f). Fla.

borealis of authors, equals *Hybomitra sexfasciata.*

boreus Stone, see *Hybomitra.*

brennani Stone, see *Hybomitra.*

caesiofasciatus Macquart, equals *giganteus.*

13. *calens* Linnaeus, 1767, Syst. Nat., ed. 12, **1**:1000. Type, (sex ?), Amer.; location unknown. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:472. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 163 (unrecognized species).

californicus Hine (not Marten), equals *Hybomitra epistates.*

californicus Marten, see *Hybomitra.*

canadensis Curran, equals *Hybomitra septentrionalis.*

captonis Marten, see *Hybomitra.*

carolinensis Macquart, see *Hybomitra.*

catenatus Osten Sacken (not Walker), equals *recedens.*

14. *catenatus* Walker, 1848, List, I, p. 148. Type, ♀, Mass.; B.M.N.H. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 227. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 102. (f, synonymy). Philip, 1941, Canad. Ent.,

73:107. Chagnon and Fournier, 1943, Nat. Canadien, **70**:77. Male, see *orion* below. Que., *Me., Mass., *Conn., N.Y., N.J., *Pa., Del., N.C., *Mich., Minn.

Tabanus orion Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:442. Cotypes, ♂, 8♀♀, "Canada; Nahant, Mass.; Suffield, Conn.; Beverly, Mass.; N.Y."; M.C.Z. No. 4035. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 113.

catenatus Osten Sacken (not Walker), equals *recedens.*

15. *cayensis* Fairchild, 1935, Fla. Ent., **18**:53. Type, ♀, Stock Island, near Key West, Fla.; M.C.Z. No. 20134. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 119 (f). Male unknown. So. Fla.

centron Marten, equals *Hybomitra rhombica.*

centron Rowe and Knowlton (not Marten), equals *Hybomitra tetricus.*

cerastes Osten Sacken, equals *Hamatabanus scitus.*

16. *cheliopterus* Rondani, 1850, Nuovi Ann. Stor. Bologna, (3) **3**:192. Type, ♀, Car.; Royal Mus. Turin. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 228 (synonymy). Stone, 1938, U.S.D.A. No. 305, p. 109 (f, synonymy, ♂). Va., N.C., Ga., Fla., *Ala., *Miss., La., Tex.

Tabanus fronto Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:431. Cotypes, 5♀♀, Ga.; M.C.Z. No. 4031. Hine, 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 48.

16a. subsp. *subfronto* Philip, 1936, Jour. Kans. Ent. Soc., **9**:100 (*Tabanus*). Type, ♀, Raleigh, N.C.; Coll. Philip. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 109 (syn. of *cheliopterus*). Philip, 1941, Canad. Ent., **73**:108. N.C., Ga., Fla.

cinctus Fabricius, see *Hybomitra.*

17. *cingulatus* Macquart, 1838, Dipt. exot. nouv. peu connus, I, pt. 1, p. 148 (orig. Mem., Lille, 1838, p. 144). Type, ♀, Philadelphia, Pa.; collection unknown. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 109 (?synonym of *cheliopterus*). Philip, 1941, Canad. Ent., **73**:108 (unrecognized species). Not. Thünberg, 1827, Nova Acta Upsala, **9**:58 (f).

18. *coarctatus* Stone, 1935, Proc. Ent. Soc. Wash., **37**:13 (f). Type, ♀, Immokalee, Fla.; U.S.N.M. No. 50615. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 111 (f). Male unknown. Ga., Fla.

19. *coffeatus* Macquart, 1847, Dipt. exot. nouv. peu connus, Sup. 2, p. 23 (orig. Mem., Lille, 1847, p. 39). Type, ♂, Philadelphia; collection unknown. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:441 (♀). Hine, 1904, Ohio Nat., **5**:235; 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 46 (f). Schwardt and Hall, 1930, Ark. Agr. Exp. Sta. Bull. No. 256, p. 26. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 100 (f). Mass., *Conn., N.Y., N.J., Del., Pa., Md., D.C., Va., N.C., Ga., Fla., La., Ark., Ind., Mich., ?Colo. (fide Hine).

?*Tabanus nigripes* Wiedemann, 1821, Dipt. Exot., **1**:75. Type, ♂, Savannah, Ga.; Copenhagen Zool. Mus. (?).

comastes Williston, equals *Hybomitra captonis.*

comes Walker, equals (?) *Hybomitra astuta.*

commixtus Walker, equals *lineola* (?).

compactus Aldrich (lapsus), equals *lineola.*

confusus Walker, equals *recedens.*

conterminus Walker, equals *nigrovittatus.*

costalis Wiedemann (not Lichtenstein), equals *quinque-vittatus.*

20. *crassicornis* Wiedemann, 1821, Dipt. Exot., 1, p. 71. Type, ♀, America?; collection unknown. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 164. Philip, 1941, Canad. Ent., **73**:108. A very doubtfully nearctic species.

crepuscularis Bequaert, see *Chlorotabanus.*

21. *cribellum* Osten Sacken, 1886, Biol. Centr.-Amer. Insec., Dipt., **1**:52 (*Tabanus*). Cotypes, 3 ♀ ♀, Presidio, Mex.; B.M.N.H. (2 now present). Hine, 1904, Ohio Nat., **5**:236. Rowe and Knowlton, 1935, Canad. Ent. **67**:241 (f). Philip, 1942, Proc. N. Eng. Zool. Club, **21**:58. Male, see *Agelanius cribellum* below. Utah, N.M., [Mexico].

Stenotabanus cribellum. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 36 (f).

Diachlorus guttatulus Townsend, 1893, Trans. Kans. Acad., Sci., **13**:134. Cotypes, 7 ♀ ♀, Las Cruces, N.M.; U.S.N.M.

Tabanus guttatulus (Townsend), 1897, Psyche, **8**:147.

Agelanius cribellum. Philip, 1941, Canad. Ent., **73**:12 (♂).

cristatus Curran, equals *Hybomitra gracilipalpis* (?).

22. *cymatophorus* Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:444. Type, ♀, near Mammoth Cave, Ky.; M.C.Z. No. 4037. Hine, 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 47 (f)). Schwardt and Hall, 1930, Ark. Agr. Exp. Sta. Bull. No. 256, p. 26 (f). Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:190 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 80 (f). N.Y., Md., *Ga., La., Tex., Ark., Ky., Ill.

daeckei Hine, see *Hybomitra*.

dawsoni Philip, equals *sagax*.

23. *difficilis* Wiedemann, 1828, Auss. zweifl. Ins., **1**:165. Type, ♀, "Vaterland?"; Vienna Nat. Mus., now missing. Szilady, 1926, Biol. Hungarica, 1 (fasc. 7), p. 30 (type labelled "Amer. Bor."!). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 164 (unrecognized species).

dodgei Whitney, see *Anacimas*.

24. *dorsifer* Walker, 1860, Trans Ent. Soc. London, **5**:273. Type, ♀, Mexico; B.M.N.H. Philip, 1936, Bull. Brooklny Ent. Soc., **31**:191 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 56 (f). Ariz., Tex., [Mexico].

Tabanus sexvittatus Bigot, 1892, Mem. Soc. Zool. Fr., **5**:682. Cotypes, 2 ♀ ♀, Mexico; B.M.N.H. (1 now present).

Tabanus intensivus Townsend, 1897, Psyche, **8**:93. Cotypes, 2 ♀ ♀, West Fork, Gila River, N. Mex.; B.M.N.H. Philip, 1941, Canad. Ent., **73**:144 (synonymy).

Tabanus hyalinipennis Hine, 1904, Canad. Ent., **35**:244. Cotypes, unstated no. ♀ ♀, Oak Creek Canyon, Ariz.; Ohio S. U. Hine, 1904, Ohio Nat., **5**:238.

dorsonotatus Macquart, equals *fumipennis*.

duplex Walker, see *Atylotus*.

25. *endymion* Osten Sacken, 1878, Mem. Boston Soc. Nat. Hist., **2** (sup):556. Cotypes, 2 ♂ ♂, 2 ♀ ♀, Ga. (lectotype, ♀, Stone, 1938). M.C.Z. No. 4047. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 108 (f). N.C., Ga., Fla.

epistates Osten Sacken, see *Hybomitra*.

epistatus Hine (lapsus), equals *Hybomitra epistates*.

26. *equalis* Hine, 1923, Ohio Jour. Sci., **23**:205 (change of name). Stone, 1938, U.S.D.A., Misc. Publ. No. 305, p. 113 (f). *Ill., Iowa, Kan., *Mo., Okla., Ark., La., Miss., Ala.

Tabanus uniformis Hine, 1917, Ohio Jour. Sci., **17**:270 (♂). Type, ♀, Jackson Co., Kan.; Ohio S. U. Not Ricardo, 1911, Records Ind. Mus., **4**:218.

Tabanus aequalis Jones and Bradley, 1924, Jour. Econ. Ent., **17**:50 (lapsus).

27. *erythraeus* (Bigot), 1892, Mem. Soc. Zool., Fr., **5**:661 (*Atylotus*). Type, ♀, Mexico; B.M.N.H. Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:191 (♂).

Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 58 (f). Ariz., [Mexico].
erythroletus of authors (lapsus), equals *erythrotelus*.
erythrotelus Walker, equals *reinwardtii*.

28. *euryceru*s Philip, 1937, Pan-Pac. Ent., **13**:66 (♂). Type, ♀, Santa Rita Mts., Ariz.; Coll. Philip. Ariz.
Tabanus euryceras Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 65 (f) (lapsus).
excessus Stone, equals *imitans* subsp.

29. *exilipalpis* Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 54 (f). Type, ♀, Beaufort, So. Car.; U.S.N.M. No. 51961. Male unknown. S.C., *Miss.
exul Osten Sacken, equals *sulcifrons*.

30. *fairchildi* Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 63 (♂, f). Type, ♀, Taghanic, Ithaca, N. Y.; U.S.N.M. No. 51963. *Ont., *Que., N.Y., Pa., Conn., N.J., Del., Md., D.C., Va., N.C., Ohio, Ind., Ky., *Mo., Okla., Ark., N.C., B.C.
Tabanus vivax of authors. Hine, 1903, Ohio Nat., **4**:1-2; 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 56; 1906, U.S.D.A., Bur. Ent. Tech. Ser. **12**:32 (lf, pf, f). Schwardt, 1936, Ark. Agr. Exp. Sta. Bull No. 332, p. 57 (ef). Not Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:446.
ferrugatus (Fabricius) Wiedemann, equals *Diachlorus ferrugatus*.

31. *ferrugineus* Palisot de Beauvois, 1813-20, Ins. rec. en Afr. et en Amer., p. 221 (f). Type, ♀, United States; presumably lost. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 165 (unrecognized species). Philip, 1941, Canad. Ent., **73**:107.
flavidus Hine, see *Stenotabanus*.
flavipes Wiedemann, equals *Hybomitra aequetincta*.
flavocinctus Bellardi, equals *Hybomitra zonalis*.
flavus Macquart (not Wiedemann), equals *Chlorotabanus crepuscularis*.
floridanus Szilady, equals *quinquevittatus*.

32. *floridensis* Hine, 1912, Ohio Nat., **12**:513. Type, ♀, Fort Meade, Fla:; Ohio S. U. Fla., Ga.?
fratellus Williston, see *Glaucops*.
frenchii (Marten), see *Hybomitra*.
frenchii Hine (not Marten), equals *Hybomitra tetrica*.
fretus Stone, see *Hybomitra*.
frontalis Walker, equals *Hybomitra septentrionalis* subsp.
fronto Osten Sacken, equals *cheliopterus*.
fulcifrons Macquart (misprint), equals *sulcifrons*.
fulvescens Walker, equals *Atylotus bicolor*.

33. *fulvicallus* Philip, 1931, Minn. Agr. Exp. Sta. Tech. Bull. No. 80, p. 106. Type, ♀, Lake Minnetonka, Minn.; U. Minn. Fairchild, 1934, Occ. Papers. Boston Soc. Nat. Hist., **8**:143 (f). Stone, 1935, Proc. Ent. Soc. Wash., **37**:17; 1938, U.S.D.A. Misc. Publ. No. 305, p. 66 (f). Male unknown. Ont., Minn., Mich., N.Y.
fulvofrater Walker, equals *fulvulus*.
fulvopilosus Johnson, equals *atratus* subsp.

34. *fulvulus* Wiedemann, 1828, Auss zweifl. Ins., **1**:153. Type, ♀, "America"; Vienna N.H. Mus. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:451 (partim, ♂). Hine, 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 49 (f); 1914, Ohio Nat., **14**:226. Schwardt and Hall, 1930, Ark. Agr. Exp. Sta. Bull. 256, p. 26. Fairchild, 1934, Boston Soc. Nat. Hist. Occ. Pap., **8**:140 (f) Philip, 1936, Ohio Jour. Sci., **36**:150. Stone, 1938, U.S.D.A. Misc. Publ

No. 305, p. 55 (f, synonymy). N.J., Del., *Pa., Md., D.C., N.C., S.C., *Ga., Fla., La., Ark., Mo., Ky., *Ill.

Tabanus fulvofrater Walker, 1848, List, I, p. 181. Type, ♀, Ill.; B.M.N.H. Philip, 1941, Canad. Ent., **73**:108 (synonymy).

?*Tabanus mutatus* Walker, 1850, Ins. Saund., Diptera, **1**:23. Type, ♀ United States; B.M.N.H. (now missing).

34a. subsp. *pallidescens* Philip, 1936, Ohio Jour. Sci., **36**:150 (♂). Type, ♀, Blue Mts., Miss.; Coll. Philip. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 56. Md., Tenn., Ark., Ga., Fla., Miss., Mo., La.

35. *fumipennis* Wiedemann, 1828, Auss. zweifl. Ins., **1**:119. Type, ♂, Savannah, Ga.; Vienna Nat. Mus. Stone, 1935, Proc. Ent. Soc. Wash., **37**:18 (synonymy); 1938, U.S.D.A. Misc. Publ. No. 305, p. 96 (f). Philip, 1941, Canad. Ent., **73**:108 (synonymy). S.C., Ga., Fla.

Tabanus rufus Palisot de Beauvois, 1809, Ins. rec. en Afr. et en Amer., p. 100 (f); not Scopoli, 1763, Ent. Carn., p. 373. Type, ♀, United States; collection unknown. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:456; 1878, 2 (sup.):559 (♂).

Tabanus dorsonotatus Macquart, 1847, Dipt. exot. nouv. peu connus, Sup. 2, p. 22 (orig. Mem., Lille, 1847, p. 38). Type, ♂, Carolina; B.M.N.H. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 164 (unrecognized species). Philip, 1941, Canad. Ent., **73**:108.

Stigmatophthalmus rufa. Enderlein, 1925, Mitt. Zool. Mus. Berlin, **11**:387.

fur Williston, 1887 (not 1901), equals *recedens*.

36. *fuscicostatus* Hine, 1906, Ohio Nat., **7**:24. Cotypes, unstated no. ♀♀, Baton Rouge and other localities, La.; Ohio S. U., U.S.N.M. (?), and Coll. Philip. Hine, 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 49 (f). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 119 (f). Male unknown. N.C., S.C., *Miss., La., *Tex., *Kan.

fuscipalpis Bigot, equals *sequax*.

fusconervosus Macquart, equals (?) *turbidus*.

fuscopunctatus Howard (not Macquart), equals *imitans* subsp. *excessus*.

fuscopunctatus Macquart, equals *imitans*.

37. *giganteus* Degeer, 1776, Mem. pour servira l'hist. des ins., **6**:226 (f). Type, ♀, Pa.; collection unknown. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:458. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 51. Stone, 1938, U.S.D.A. Misc .Publ. No. 305, p. 84 (f). Marchand, 1918, Trans. Amer. Ent. Soc., **44**:175. Male?, see *caesiofasciatus* below. Mass. (?), N.Y., Pa., N.J., Md., Va., N.C., *Ga., Fla., Ohio, Ind., Ill., *Ky., Mo., Tenn., Ark., La., Okla., Tex.

Tabanus lineatus Fabricius, 1781, Species Ins., **2**:455. Type, ♀, America; collection unknown. Wiedemann, 1828, Auss. zweifl. Ins., **1**:115.

?*Tabanus pallidus* Palisot de Beauvois, 1809, Ins. rec. en Afrique et en Amer., 100 (f). Type, ♀, United States; collection unknown.

Tabanus bicolor Macquart, 1847, Dipt. exot. nouv. peu connus, Sup. 2, p. 21 (orig. Mem., Lille, 1847, p. 37). Type, ♀, South Carolina; B.M.N.H.

Tabanus caesiofasciatus Macquart, 1855, Dipt.. exot. nouv. peu connus, Sup. 5. p. 32 (orig. Mem., Lille, 1855, p. 52). Type, ♂, Baltimore, Md.; B.M.N.H.? (see Philip, 1940, Canad. Ent., **73**:108).

gilanus Rowe and Knowlton (not Townsend), equals *stonei*.

gilanus Stone (not Townsend) (partim), equals *stonei* subsp. *jellisoni*.

38. *gilanus* Townsend, 1897, Psyche, **8**:92. Cotypes, 2♀♀, West Fork, Gila River, N. Mex.; B.M.N.H. (1 damaged specimen). Hine, 1904, Ohio Nat., **5**:238. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 61 (♂?, f, partim) Philip, 1941, Canad. Ent., **73**:144 (synonymy). Ariz., N.M.

39. *gladiator* Stone, 1935, Proc. Ent. Soc. Wash., **37**:12 (f). Type, ♀, Charleston, S.C.; U.S.N.M. No. 50613. Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:192 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 85 (f). Va., N.C., S.C., Ga., Fla.

gracilipalpis Hine, see *Hybomitra*.

gracilis Sanborn, Stiles and Moe (not Wiedemann), equals *abactor*.

40. *gracilis* Wiedemann, 1828, Auss. zweifl. Ins., **1**:156. Type, ♀, Savannah, Ga.; Vienna Nat. Mus. Osten Sacken, 1878, Smithsn. Misc. Coll., 270, p. 228. Williston, 1887, Kans. Acad. Sci. Trans. **10**:140. Philip, 1936, Ohio Jour. sci., **36**:153. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 68 (♂, f). N.J., Va., N.C., Ga., Fla., *Miss., Ark.?

guttatulus Townsend, equals *Agelanius cribellum*.

41. *guttatus* Wiedemann, 1821, Dipt. Exot., p. 73. Type, ♀, America; orig. in Germar's Coll., Halle. Wiedemann, 1828, Auss. zweifl. Ins., **1**:133. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 165 (unrecognized species).

haemaphorus Marten, see *Hybomitra*.

hearlei Philip, see *Hybomitra*.

hinei Johnson, see *Hybomitra*.

hipparionis Cockerell, see fossil species.

hirtioculatus Macquart, equals *Hamatabanus scita*.

hirtulus (Bigot), equals *Hybomitra tetrica* subsp.

hyalinipennis Hine, equals *dorsifer*.

illotus Osten Sacken, see *Hybomitra*.

42. *imitans* Walker, 1848, List, I, p. 146. Type, ♀, Ga.; B.M.N.H. Osten Sacken, 1878, Smithsn. Misc. Coll. No. 270, p. 228. Stone, 1935, Proc. Ent. Soc. Wash., **37**:86 (f, synonymy). N.C., S.C., Ga., Fla., *Miss.

Tabanus fuscopunctatus Macquart, 1850, Dipt. exot. nouv. peu connus, Sup. IV, p. 34 (orig. Mem., Lille, 1850, p. 338). Type, ♀, Ga.; Lille Mus.? Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:432; 1878 2 (sup.):559 (♂). Marchand, 1918, Trans. Amer. Ent. Soc. **44**:175 (f).

42a. subsp. *excessus* Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 87. Type, ♀, Enterprise, Fla.; U.S.N.M. No. 51967. Male unknown. Fla.

Tabanus fuscopunctatus Howard 1901, (not Macquart), The Insect Book, pl. 16, fig. 9.

imitans Walker 1848, p. 173 (not p. 146), equals *Atylotus duplex*.

incisuralis Macquart, see *Atylotus*.

insuetus Osten Sacken, equals *Atylotus incisuralis*.

incisus Walker, equals *Hybomitra septentrionalis* subsp. *frontalis*.

inscitus Walker 1848, p. 172 (not p. 161), equals *Hybomitra comes* (?*astutus*).

intensivus Townsend, equals *dorsifer*.

intensivus of authors (not Townsend), equals *stonei*.

intermedius Walker, equals *Atylotus incisuralis*.

itasca Philip, see *Hybomitra*.

43. *johnsoni* Hine, 1907, Ohio Nat., **8**:225. Cotypes, unstated no. ♀♀, St. Augustine, Fla.; Ohio S.U. and M.C.Z. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 79. Philip, 1940, Canad, Ent., **73**:108 (♂). Fla.

44. *kisliuki* Stone, 1940, Proc. Ent. Soc. Wash., **42**:59 (f, ♂). Type, ♀, Helena Miss.; Ohio S.U. Miss.

45. *lacustris* Stone, 1935, Proc. Ent. Soc. Wash., **37**:13 (f). Type, ♀, Lakeland, Fla.; U.S.N.M. No. 50616. Stone, 1938, U.S.D.A. Misc. Publ. No 305, p. 104 (♂, f). Ga., Fla.

laniferus McDunnough, see *Hybomitra.*

lasiophthalmus Macquart, see *Hybomitra.*

lateritius Rondani, equals *rufofrater.*

laticallus Philip, see *Hybomitra.*

46. *laticeps* Hine, 1904, Ohio Nat., **5**:239. Cotypes, unstated no. ♂♂ ♀♀, Calif. and Wash.; Ohio S.U. and Coll. Philip. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 62 (f). Wash., Ore., Calif., N.M.

laticornis Hine, see *Hybomitra.*

47. *leucomelas* Walker, 1848, List, I, 175. Type, ♀, Ga.; B.M.N.H. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 166 (unrecognized species). Philip, 1941, Canad. Ent., **73**:147 (redescription).

leucophorus (Bigot), equals *sequax.*

limbatus Palisot de Beauvois, equals *americanus.*

limpidipennis Hine, equals *pruinosus.*

lineatus Fabricius, equals *giganteus.*

48. *lineola* Fabricius, 1794, Ent. Syst., **4**:369. Type, ♀, "Amer. boreali"; U. Kiel Mus. (fragments). Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:448 (synonymy, partim). Hine, 1906, Ohio Nat., **7**:21. Marchand, 1918, Trans. Amer. Ent. Soc., **44**:175. (f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:203. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 122 (f, partim). Bequaert, 1940, Rev. Ent., **11**:357 (f, partim). Philip, 1942, Psyche, **99**:27. Fairchild, 1942, Ann. Ent. Soc. Amer., **35**:167 (f, synonymy). Kroe Chagnon and Fournier, 1943, Nat. Canadien, **70**:78. Que., Ont., Me., Mass., Conn., N.Y., Pa., Del., D.C., Md., Va., N.C., Ga., Fla., La., Tenn., Ohio, Mich., Kan.?

Tabanus vicarius Walker, 1848, List, I, p. 187 (partim, "Mass." specimen).

?*Tabanus commixtus* Walker, 1860, Trans. Ent. Soc. London, **5**:273. Type, ♀, Mexico; B.M.N.H. Philip, 1942, Psyche, **99**:27.

Tabanus compactus Aldrich, 1905, Smithsn. Misc. Collect. No. 1444, p. 204 (lapsus).

Tabanus quinquevittatus Hine, 1906, Ohio Nat., **7**:26; 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 55; not Wiedemann, 1821, Dipt. Exot., p. 84.

Tabanus quinquemaculatus Hine, 1904, U. S. Dept. Agr. Div. Ent. Bull., **44**:58 (lapsus).

48a. subsp. *scutellaris* Walker, 1850, Ins. Saund., Dipt., **1**:27. Type, ♀, "Bolton, North America"; lost. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 123. Philip, 1942, Psyche, **99**:28. Chagnon and Fournier, 1943, Nat. Canadien, **70**:78. Male, see Osten Sacken below. B.C., *Alta., *Sask., *Man., Ont., Que., Mass., *Conn., *N.Y., *N.J., *Del., *Pa., *Md., D.C., W.Va., Ohio, *Mich., *Ind., Ill., *Wis., Minn., Iowa, Kan., *Neb., *S.D., *N.D., *Mont., *Wyo., Colo., Utah, *Ida., Nev., Calif., *Ore., *Wash.

Tabanus lineola of authors (partim). Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:448 (♂). Hart, 1895, Bull. Ill. Lab. Nat. Hist., **4**:235 (l, pf). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 51; 1907, La. Agr. Expt. Sta. Bull. No. 93, p. 50 (f). ?Malloch, 1917, Bull. Ill. Lab. Nat. Hist., **12**:359 (l, pf). Philip, 1931, Minn. Agr. Exp. Sta. Bull. No. 80, pp. 32, 109, 124, 125 (l, pf).

liorhinus Philip, see *Hybombitra.*

longiglossus Philip, see *Hybomitra.*

49. *longiusculus* Hine, 1907, Ohio Nat., **8**:226. Cotypes, unstated no. ♀♀, So. Pines, N. C. and Mimsville, Ga.; Ohio S. U., Kans. U., Coll. Phiilp, U.S.-N.M. (?). Philip, 1936, Ohio Jour. Sci., **36**:151 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 71 (f). N.C., *S.C., Ga., Fla

50. *longus* Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:447. Cotypes, 4♀♀ (lectotype, ♀, Middle Atlantic States, Stone, 1938); M.C.Z. No. 4043. Hine, 1914, Ohio Nat., **14**:227 (partim). Schwardt and Hall, 1930, Ark. Agr. Exp. Sta. Bull. 256, p. 25. Fairchild, 1934, Boston Soc. Nat. Hist. Occ. Pap., **8**:140 (f). Philip, 1936, Ohio Jour. Sci., **36**:149. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 75 (f). Male unknown. Pa., N.J., Md., Va., N.C., *Ga., Ohio, Ky., Ark., *Miss., Okla., *Mo., *Kan., ?N.Y.

longus Osten Sacken (partim), equals *sackeni.*
lugubris Macquart (not Linnaeus), equals *Whitneyomyia beatificus.*
magnicallus Stone, see *Aegialomyia.*

51. *marginalis* Fabricius, 1805, Syst. Antl., p. 99. Type, ♀, No. Amer.; collection unknown. Wiedemann, 1828, Auss. zweifl. Ins., **1**:166. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:472; 1878, Smithsn. Misc. Collect. No. 270, p. 228. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 166 (unrecognized species).

maritimus Townsend, equals *Aegialomyia magnicalla.*
megerlei Wiedemann, see *Agkistrocerus.*

52. *melanocerus* Wiedemann, 1828, Auss. zweifl. Ins., **1**:1828. Type, ♀, Ky.; Vienna Nat. Mus. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:440. Hine, 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 51 (f). Brimley, 1911, Ent. News, **22**:133. Marchand, 1918, Trans. Amer. Ent. Soc., **44**:175 (f). Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:106 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 106 (f). Conn., N.J., *Pa., Del., Md., Va., N.C., Ga., Fla., *Ala., *Miss., La., Ark.

melanorhinus (Bigot), see *Hybomitra.*
merychippus Cockerell, see fossil species.
metabolus McDunnough, see *Hybomitra.*
mexicanus of authors (not Linnaeus), equals *Chlorotabanus crepuscularis.*
microcephalus Osten Sacken, see *Hybomitra.*
milleri Whitney, equals *sparus* subsp.
minusculus Hine, see *Hybomitra.*

53. *moderator* Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 98 (f). Type, ♀, Atlanta, Ga.; U.S.N.M. No. 51969. Philip, 1940, Canad. Ent., **73**:108 (♂). Ga., *Miss., Ark.

54. *molestus* Say, 1823, Jour. Acad. Nat. Sci. Philad., **3**:31. Type, ♀, Mo.; destroyed. Wiedemann, 1828, Auss. zweifl. Ins., **1**:125. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:438. Hine, 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 52 (f, ♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 97 (f, synonymy). N.J., Pa., Md., D.C., *W.Va., Va., N.C., Ky., Mo., Kan., *Ill., Ark., Tenn., La., Ga., *Miss., Fla.,

Atylotus tenessensis Bigot, 1892, Mem. Soc. Zool. Fr., **5**:660. Type, ♀, Tenn.; B.M.N.H. Philip, 1941, Canad. Ent., **73**:110 (synonymy).

55. *monoensis* Hine, 1924, in Webb and Wells, U.S.D.A., Dept. Bull. 1218, p. 29 (♂, f). Type, ♀, Topaz, Calif.; U.S.N.M. No. 24950. Stone, 1938, U.S.-D.A. Misc. Publ. No. 305, p. 81 (f). Calif., Ore.

56. *morbosus* Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 89 (f). Type, ♀ Huachuca Mts., Ariz.; U.S.N.M. No. 51968. Male unknown. Ariz.

57. *mularis* Stone, 1935, Proc. Ent. Soc. Wash., **37**:15 (f). Type, ♀, Baton Rouge, La.; U.S.N.M. No. 50618. Stone, 1938, U.S.D.A. Misc. Publ. No. 503, p. 121 (f, ♂). Philip, 1942, Psyche, **49**:39. Md., Va., N.C., S.C., Ga., Fla., Ala., Miss., La., *Tenn., *Ark., *Okla., *Kan.

mutatus Walker, equals (?) *fulvulus.*

nantuckensis Hine, equals *atratus* subsp.

nanus Macquart, equals *Stenotabanus magnicallus.*

58. *nebulosus* Palisot de Beauvois, 1813-30, Ins. rec. en Afr. et en Amer., 222 (f's); not Degeer, 1776, Mem. Ins., **6**:227, pl. 30, fig. 2. Cotypes, 2♀♀, United States; collection unknown. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 166 (unrecognized species).

59. *nefarius* Hine, 1907, Ohio Nat., **8**:224. Cotypes, 3♀♀, New Orleans (labelled "on train near Gretna") and LeCompte, La.; Ohio S.U. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p .111 (f). Male unknown. So. La.

niger Palisot de Beauvois, equals *atratus.*

60. *nigrescens* Palisot de Beauvois, 1809, Ins. rec. en Afr. et en Amer., p. 100 (f). Type, ♀, United States; collection unknown. Wiedemann, 1828, Auss. zweifl. Ins., **1**:116. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:453 (♂). Hart, 1895, Ill. State Lab. Nat. Hist. Bull. **4**:238 (p). Malloch, 1917, Bull. Ill. Lab. Nat. Hist., **12**:361 (l, pf). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 92 (f). Mass., *Conn., N.Y., N.J., Pa., Md., Va., N.C., S.C., *Ga., Fla., Miss., Ark., Mich., Ind., Ohio.

Tabanus nigricans Johannsen, 1935, Cornell Mem. 177, p. 15 (lapsus).

60a. subsp. *atripennis* Stone, 1935, Proc. Ent. Soc. Wash., **37**:15 (♂). Type, ♀, Stillwater, Okla.; U.S.N.M. No. 50619. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 93 (f). Md., Fla., Tex., Okla., Kan.

nigripes Wiedemann, equals (?) *coffeatus.*

nigrotuberculatus Fairchild, equals *Hybomitra aequalincta.*

61. *nigrovittatus* Macquart, 1847, Dipt. exot. nouv. peu connus, Sup. 2, p. 24 (orig. Mem., Lille, 1847, p. 40). Cotype, ♀, Nova Scotia; B.M.N.H. (probably confused now). Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:449 ♂, synonymy). Hine, 1906, Ohio Nat. **7**:25; 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 53. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 120 (f, synonymy). Bequaert, 1940, Rev. Ent., **11**:250. Philip, 1942, Psyche, **49**:39. N.S., Me., Mass., R.I., Conn., N.Y., N.J., *Pa., Del., Md., Va., N.C., S.C., *Ga., Fla., *Miss., La., Tex., Bermuda [Antilles].

Tabanus simulans Walker, 1848, List, I, 182. Type, ♀, Nova Scotia; B.M.N.H.

Tabanus conterminus Walker, 1850, Ins. Saund., Dipt., **1**:24. Cotypes, 2♀♀, United States; B.M.N.H.

Tabanus pauper Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:450 (MS).

?*Tabanus allynii* Marten, 1883, Canad. Ent., **15**:110. Type, ♀, North Carolina; destroyed.

nippontucki Philip, equals *vittiger* subsp.

62. *nivosus* Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:445. Cotypes, ♂, 2♀♀, New Jersey (lectotype, ♀, Stone, 1938); M.C.Z. No. 4041. Cameron, 1926, Bull. Ent. Research, **17**:32 (lf, pf). Stone, 1930, Ann. Ent. Soc. Amer., **23**:298 (lf, p). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 31, 112 (l, pf). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 64 (f). Chagnon and Fournier, 1943, Nat. Canadien, **70**:77. N.S., Que., Ont., *Man., Sask., Alta., B.C., N.H., Vt., Mass., Conn., *R.I., N.Y., N.J., Del., Ark., Ohio, *Mich., Wis., Minn., *Mont., *Wyo., Colo.

notabilis Walker, equals *Hybomitra lasiophthalma.*

novae-scociae Macquart, equals *actaeon.*
nudus McDunnough, see *Hybomitra.*
ohioensis Hine, see *Atylotus.*
oklahomensis Stone, see *Hybomitra.*
opacus Coquillett, see *Hybomitra.*
opacus Hine (not Coquillett), equals *Hybomitra tetrica.*

63. *orbicallus* Philip, 1936, Canad. Ent., **68**:157 (♂). Type, ♀, Gove Co., Kans.; Coll. Philip. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 59 (f). S.D., Neb., Kan., Okla., Iowa.
orion Osten Sacken, equals *catenatus.*
osburni Hine, equals *Hybomitra rhombica* subsp.
pallidescens Philip, equals *fulvulus* subsp.
palpinus Palisot de Beauvois, equals (?) *giganteus.*
palpinus Palisot de Beauvois, equals (?) *wiedemanni.*
patulus Walker, equals *Hybomitra carolinensis.*
pemeticus Johnson, see *Atylotus.*

64. *petiolatus* Hine, 1917, Ohio Jour. Sci., **17**:270. Type, ♀, Lecompte, La.; Ohio S.U. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 105 (f). Male unknown. Del., N.C., Fla., *Ga., La.
phaenops Osten Sacken, equals *Hybomitra sonomensis* subsp.
philipi Stone, see *Hybomitra.*
plumbeus Drury, equals *americanus.*
politus (Johnson) (not Walker), equals *Hybomitra hinei.*
procyon Osten Sacen, see *Hybomitra.*

65. *productus* Hine, 1904, Ohio Nat., **5**:242. Cotypes, unstated no. ♂♂, ♀♀, Lander, Wyo., 5-7,000 feet; Ohio S.U. Rowe and Knowlton, 1935, Canad. Ent., **67**:243. *Mont., Wyo., *Colo., Utah. *Ore., Calif., N.M.
Stenotabanus productus (Hine). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 35 (f). Philip, 1941, Canad. Ent., **73**:11 (synonymy).

66. *proximus* Walker, 1848, List, I, p. 147. Type, ♀, St. Louis, "Fla."; B.M.N.H. Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:193 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 91 (f, synonymy). Philip, 1941, Canad. Ent., **73**:109 (St. Louis, Mo., not "Fla.", type loc.). Va., *Ga., Fla., *Miss., La., Tex., Okla., Ark., Mo., Ill.
Tabanus benedictus Whitney, 1904, Canad. Ent., **36**:206. Cotypes, 4♀♀, "Louisiana, Mo."; M.C.Z. No. 17,058. Hine, 1904, Ohio Nat., **5**:235; 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 45 (f). Bequaert, 1933, Boston Soc. Nat. Hist. Occ. Pap., **8**:85. Schwardt, 1936, Ark. Agr. Exp. Sta. Bull. No. 332, p. 33 (ef).

67. *pruinosus* Bigot, 1892, Mem. Soc. Zool. Fr., **5**:683. Type, ♂, Mexico; B.M.N.H. (Stone, 1938—"not located on recent search"; found in 1940, however). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 65 (f, synonymy). Female, see Townsend below. Utah, Ariz., N.M., (Mexico).
Tabanus vivax Townsend, 1892, Trans. Kan. Acad. Sci., **13**:135 (♀); not Osten Sacken, 1876. Mem. Boston Soc. Nat. Hist., **2**:446.
Tabanus limpidivennis Hine, 1907, Ohio Nat., **8**:223. Cotypes, ♂, ♀, Guatemala; Ohio S.U.
pruinosus Hine (not Bigot), equals *Atylotus ohioensis.*
psammophilus Osten Sacken, see *Aegialomyia.*

68. *pumilus* Macquart, 1838, Dipt. exot. nouv. peu connus, I, pt. 1, p. 146 (orig. Mem., Lille, 1838, p. 150). Type, ♀, "Carolina"; collection unknown. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:448 (♂). Hine, 1903, Ohio State

Acad. Sci., Spec. Pap. **5**:53; 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 54 (f). Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:196. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 75 (f). Me., Mass., *R.I., *Conn., N.Y., N.J., Del., *Pa., D.C., Md., *Va., N.C., *Ga., Fla., Miss., La., Ark., *Mich.

69. *punctifer* Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:453. Cotypes, unstated no. ♂♂, ♀♀ (lectotype, ♀, "Utah," Stone, 1938); M.C.Z. No. 4044. Hine, 1904, Ohio Nat., **5**:242. Webb and Wells, 1924, U.S.D.A. Dep. Bull. 1218, p. 10 (ef, lf, pf). Herms, 1927, Pan-Pac. Ent. **4**:91, (l, lf). Rowe and Knowlton, 1935, Canad. Ent., **67**:243. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 93 (f). Wash., Ore., Ida., *Mont., *Wyo., *Colo., Utah, Okla., Tex., Ariz., *N.M., Nev., Calif., *B.C., *Santa Cruz Is. [Mexico].

punctipennis Macquart, equals *Hybomitra lasiophthalma.*

pygmaeus Williston, see *Microtabanus.*

70. *quaesitus* Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 54 (f, ♂). Type, ♀, Colorado Co., Tex.; Kans. U. Tex., La.

quinquelineatus Macquart, equals *trimaculatus.*

quinquemaculatus Hine (lapsus), equals *lineola.*

qinquevittatus Hine (not Wiedemann), equals *lineola.*

71. *quinquevittatus* Wiedemann, 1821, Dipt. Exot., **1**:84. Type, ♀, "Mexico" (labelled "Savannah," see Philip, 1941); Vienna Nat. Mus. Philip, 1942, Psyche, **99**:38 (synonymy). Que., N.H., Vt., Mass., Conn., *R.I., N.Y., N.J., Del., Pa., Md., D.C., Va., N.C., *Ga., Fla., *Miss., La., Ark., *Tenn., *Ky., Ohio, Mich., *Ill., Kan., Nebr., *S.D.

Tabanus costalis Wiedemann, 1828, Auss. zweifl. Ins., **1**:173. Type, ♂, Kentucky; Vienna Nat. Mus. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:450. Hart, 1895, Ill. Lab. Nat. Hist., Bull., **4**:236 (l, p). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. 5, p. 50; 1906, Ohio Nat., **7**:24; 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 46 (f). Malloch, 1917, Ill. Lab. Nat. Hist. Bull., **12**:359 (l, p). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:202. Wehr, 1922, Nebr. Univ. Studies, **22**:9. Schwardt and Hall, 1930, Ark. Agr. Exp. Sta. No. 256, p. 23 (f). Schwardt, 1936, Ark. Agr. Exp. Sta. No. 332, p. 35 (ef). Not Lichtenstein, 1796, Cat. musei Zool. ditissimi Hamburgi. Febr. 3, 1796, Sect. Tertin: Ins., p. 213.

Tabanus vicarius Walker, 1848, List, I, p. 187 (partim). Cotypes, 3♀♀ (only 1, "No. Amer.", is accepted as this, though no lectotype has been established); B.M.N.H. Stone, 1935, Proc. Ent. Soc. Wash., **37**:18 (synonymy); 1938, U.S.D.A. Misc. Publ. No. 305, p. 117 (f).

Tabanus baltimorensis Macquart, 1855, Dipt. exot. nouv. peu connus, Sup. V, p. 34 (orig. Mem., Lille, 1855, p. 54). Type, ♀, Baltimore, Md.; B.M.N.H.

Tabanus floridanus Szilady, 1926, Biol. Hungarica, **1** (fasc. 7):24. Type, ♀, Miami, Fla.; D.E.I.

72. *recedens* Walker, 1848, List, I, p. 147. Type, ♀, Fla.; B.M.N.H. Williston, 1887, Trans. Kans. Acad. Sci., **10**:138 (synonymy). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 110 (synonymy, f). Male, see "*catenatus*" below. Mass., Conn., N.Y., Pa., N.J., Md., Del., N.C., S.C., Fla.

Tabanus confusus Walker, 1848, List, I, p. 147. Type, ♀, Ga.; B.M.N.H.

Tabanus catenatus Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:433 (♂); 1878, Smithsn. Misc. Collect. No. 270, p. 227. Not Walker, 1848, List, I, p. 148.

Tabanus fur Williston, 1887, Trans. Kans. Acad. Sci., **10**:139. Cotypes, 2♀♀, Fla.; Kan. U.

recedens Walker 1854 (not 1848), equals *Hybomitra captonis.*

73. *reinwardtii* Wiedemann, 1828, Auss. zweifl. Ins., **1**:130. Type, ♀, Pa.; Vienna Nat. Mus. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:461 (♂). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. 5, p. 54. Cameron, 1926, Bull. Ent. Research, **17**:35 (lf, pf). Stone, 1930, Ann. Ent. Soc. Amer., **23**:299 (lf, p). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 32, 114 (l, pf). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 82 (f). Chagnon and Fournier, 1943, Nat. Canadien, **70**:76. N.S., N.F., Que., Ont., Man., Sask., Alta., Ont., Me., Vt., Mass., Conn., N.Y., N.J., Pa., Del., Md., Va., Ga., *Miss., La., Ark., *Tenn., Ohio, *Ind., Ill., *Mich., Wis., Minn., *S.D., Neb., Kan., Colo., *Wyo., Mont.

Tabanus erythrotelus Walker, 1850, Ins. Saund., **1**:25 (*erythroletus* of authors). Type, ♀, "Bolton", No. Amer.?; B.M.N.H. (now missing).

rhombicus Andrews (not Osten Sacken), equals (?) *Hybomitra liorhina.*

rhombicus Osten Sacken, see *Hybomitra.*

rijunctus Mosier and Snyder (lapsus), equals *trijunctus.*

rondanii Bellardi, equals *Diachlorus ferrugatus.*

rubrilatus Philip, equals *Hybomitra tetrica* subsp.

ruficeps Macquart, equals *Atylotus bicolor.*

ruficornis Fabricius, equals *americanus.*

74. *rufofrater* Walker, 1850, Ins. Saund., **1**:26. Type, ♀, Ga.; B.M.N.H. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 101 (♂, f, synonymy). Philip, 1941, Canad. Ent., **73**:109 (synonymy). N.C., Ga., Fla., Miss.

Tabanus unicolor Macquart, 1847, Dipt. exot. nouv. peu connus. Sup. 2, p. 22 (orig. Mem., Lille, 1847, p. 38). Type, ♀, "Carolina"; B.M.N.H. Not Wiedemann, 1828, Auss. zweifl. Ins., 1, p. 141.
Agr. Exp. Sta .Bull. No. 93, p. 46 (f). Malloch, 1917, Ill. Lab. Nat. Hist.

Tabanus lateritius Rondani, 1864, Arch. Zool. Anat. e Fisiol., **3**:80 (change of name for *unicolor* Macq., preoccupied).

Tabanus tener Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:441. Cotypes, 4♀♀, Ga., and Indian River, Fla.; M.C.Z. No. 4034.

rufus Palisot de Beauvois, equals *fumipennis.*

rupestris McDunnough, see *Hybomitra.*

75. *sackeni* Fairchild, 1934, Boston Soc. Nat. Hist. Occas. Pap., **8**:141 (f). Type, ♀, Cumberland Gap, Ky.; M.C.Z. No. 19527. Philip, 1936, Ohio Jour. Sci., **36**:149 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 72. Conn., Mass., *N.Y., Va., *Ga., *Tenn., Ark., Ind., Ohio, Ken., Okla., Ky., Mo.

Tabanus longus Osten Sacken, 1878, Mem. Boston Soc. Nat. Hist., **2**(sup.):559 (partim). Hine, 1914, Ohio Nat., **14**:227.

76. *sagax* Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:452. Cotypes, 3♀♀ (lectotype, Illinois?, Stone, 1938); M.C.Z. No. 4046. Hine, 1906, Ohio Nat., **7**:26; 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 56 (f); 1914, Ohio Nat., **14**:226. Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 115. Fairchild, 1934, Boston Soc. Nat. Hist. Occ. Pap., **8**:141 (f, synonymy). Philip, 1936, Ohio Jour. Sci., **36**:151 (♂). Stone, 1938. U.S.D.A. Misc. Publ. No. 305, p. 73 (f). Mass., Conn., *N.Y., N.J., Pa., Md., *D.C., N.C., S.C., La., Mich., Minn., Ill., *Iowa.

Atylotus baal Townsend, 1895, Trans. Amer. Ent. Soc., **22**:151. Type, ♀, Dixie Landing, Va.; Kan. U.

Tabanus dawsoni Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, p. 105. Type, ♀, Itasca Park, Minn.; Minn. U.

schwardti Philip, equals *vittiger* subsp.

scitus Walker, see *Hamatabanus.*

scutellaris Walker, equals *lineola* subsp.

septentrionalis Loew, see *Hybomitra.*

77. *sequax* (Williston), 1887, Trans. Kans. Acad. Sci., **10**:137. Cotypes, 3♀♀, Mount Hood, Ore.; Kan. U. Hine, 1904, Ohio Nat., **5**:243 (synonymy). Rowe and Knowlton, 1935, Canad. Ent., **67**:244. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 128. Philip, 1941, Canad. Ent., **73**:147 (♂). B.C., Alta., Wash., Ore., Ida., Mont., Utah.

Therioplectes leucophorus Bigot, 1892, Mem. Soc. Zool. Fr., **5**:640. Type, ♀, Mt. Hood, Ore.; B.M.N.H.

Tabanus fuscipalpis Bigot, 1892, Mem. Soc. Zool. France, **5**:681. Type, ♀, Wash. Terr.; B.M.N.H.

sexfasciatus Hine, see *Hybomitra*.

sexvittatus Bigot, equals *dorsifer*.

simulans Walker, equals *nigrovittatus*.

socius Osten Sacken (not Walker), equals *Hybomitra epistates*.

sodalis Williston, equals *Hybomitra trispila*.

sonomensis Osten Sacken, see *Hybomitra*.

78. *sparus* Whitney, 1879, Canad. Ent., **11**:38. Cotypes, unstated no. ♀♀, Milford, N.H. (lectotype, ♀, Stone, 1938); M.C.Z. No. 4039. Williston, 1887, Trans. Kans. Acad. Sci., **10**:140. Bequaert, 1933, Boston Soc. Nat. Hist. Occ. Pap., **8**:86. Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:194 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 77 (f). N.H., Mass., Conn., N.Y., N.J., Del., *Pa., Md., D.C., N.C., *Ga., Fla., *Tenn., *Mich.

78a. subsp. *milleri* Whitney, 1914, Canad. Ent., **46**:344 (as *Tabanus milleri*). Cotypes, 20♀♀, St. Augustine, Fla.; destroyed. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 78 (synonymy). Philip, 1941, Canad. Ent., **73**:109 (♂). N.Y., *Pa., Del., N.C., S.C., *Ga., Fla., *Ala., La., Ark., Okla., *Kan., Mich.

Tabanus milleri. Bequaert, 1933, Occ. Pap. Boston Soc. Nat. Hist., **8**:86. Philip, 1936, Bull. Brooklyn Ent. Soc., **30**:195.

79. *stonei* Philip, 1941, Canad. Ent., **73**:144 (♂ synonymy). Type, ♀, Bozeman, Mont.; Coll. Philip. *B.C., Alta., Wash., *Ore., *Ida., Mont., *Wyo., Colo., Utah, N.M.?, Co. Calif.

Tabanus intensivus of authors. Hine, 1904, Ohio Nat., **5**:238. Knowlton and Thatcher, 1933, Proc. Utah Acad. Sci., **11**:293. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 60 (f). Not Townsend, 1897, Psyche, **8**:93.

Tabanus gilanus Rowe and Knowlton, 1935, Canad. Ent., **67**:241 (f, partim). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 61 (partim).

79a. subsp. *jellisoni* Philip, 1941, Canad. Ent., **73**:146. Type, ♀, Dillon, Mont.; Coll. Philip. Mont., Utah, Colo.

Tabanus gilanus of authors. Rowe and Knowlton, 1935, Canad. Ent., **67**:241 (partim). Stone, 1935, U.S.D.A. Misc. Publ. No. 305, p. 61 (partim). Not Townsend, 1897, Psyche, **8**:92.

80. *stygius* Say, 1823, Jour. Acad. Nat. Sci. Philad., **3**:33. Type, ♀, Ark., destroyed. Wiedemann, 1828, Auss. zweifl. Ins., **1**:131. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:454. Hart, 1895, Ill. Lab. Nat. Hist. Bull., **4**:239 (lf, pf). Hine, 1903, Ohio State Acad. Sci. Spec. Pap. **5**, p. 54; 1906, U.S.D.A., Bur. Ent. Tech. Ser. **12**:28 (ef, pf, f). Malloch, 1917, Bull. Ill. Lab. Nat. Hist., **12**:359 (lf, pf). Marchand, 1918, Trans. Amer. Ent. Soc. **44**:175 (f). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 28, 116 (ef, pf). Schwardt, 1936, Ark. Agr. Exp. Sta. Bull. No. 332, p. 48 (ef). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 94 (f). Me., Mass., Conn., N.Y., N.J., *Pa., Del., N.C., Fla., La., Tex., Ark., Nebr., Minn.

suberjumentarius Surcouf (lapsus), equals *superjumentarius*.

subfronto Philip, equals *cheliopterus* subsp.

81. *sublongus* Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 74 (♂, f). Type, ♀, Plummers Island, Md.; U.S.N.M. No. 51966. N.Y., Pa., Md., Va., Tenn., Mo., Ark., Kan., Okla.

Tabanus "sp.", Philip, 1936, Ohio Jour. Sci., **36**:156.

82. *subniger* Coquillett, 1935, Ent. News, **17**:48. Type, ♀, Lake Forest, Ill.; U.S.N.M. No. 8301. Stone, 1935, Proc. Ent. Soc. Wash., **37**:16 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 95 (f). Ohio, Ill., N.Y., N.J.

83. *sulcifrons* Macquart, 1855, Dipt. exot. nouv. peu connus Sup. V, p. 33 (orig. Mem., Lille, 1855, p. 53) "fulcifrons," misprint). Cotypes, 4♀♀, Baltimore, Md.; B.M.N.H. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 228. Williston, 1887, Trans. Kans. Acad. Sci., **10**:138. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 54 (♂, f); 1906, U.S.D.A., Bur. Ent. Tech. Ser. **12**:22 (pf, f); 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 56 (pf, f). McAtee and Walton, 1918, Proc. Ent. Soc. Wash., **20**:204. Davis, 1919, Ill. Nat. Hist. Survey Bull. **13**:97. Schwardt and Hall, 1930, Ark. Agr. Exp. Sta. Bull. No. 256, p. 19 (f). Schwardt, 1936, Ark. Agr. Exp. Sta. Bull. No. 332, p. 51 (ef). Stone, 1938, U.S.D.A. Misc. Publ No. 305, p. 114 (f, synonymy). N.Y., N.J., Pa., Del., Md., D.C., W.Va., N.C., Ga., Fla., *Miss., La., Tex., Okla., Ark., Kan., Neb., Iowa, *Me., Tenn., Ky., Ohio, *Ind., Mich., *Ill.

Tabanus variegatus Fabricius, 1805, Syst. Antl., p. 95. Type, ♀, No. Amer.; U. Kiel Zool. Mus. (fragments). Wiedemann, 1828, Auss. zweifl. Ins., **1**:120. Osten Sacken, 1878, Smithsn. Misc. Collect. No. 270, p. 228. Hine, 1903, Ohio State Acad. Sci. Spec. Pap. No. 5, p. 56 (♂). Not Degeer, 1776, Mem. Ins., **6**:130 (f).

Tabanus tectus Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:436. Cotypes, 6♀♀, 2♂♂, Doubling Gap, Pa.; M.C.Z. No. 4033.

Tabanus exul Osten Sacken, 1878, Mem. Boston Soc. Nat. Hist., **2** (sup.):558. Cotypes, 20♀♀, 3♂♂, D.C., Md., Pa. and N.J.; M.C.Z. No. 4032, Coll. Philip. Williston, 1887, Trans. Kans. Acad. Sci., **10**:128. Townsend, 1895, Trans. Amer. Ent. Soc., **22**:60. Hine, La. Agr. Exp. Sta. Bull. No. 93, p. 48. Garman, 1910, Ky. Agr. Exp. Sta. Bull. No. 151, p. 168 (f). Marchand, 1918, Trans. Amer. Ent. Soc., **44**:175 (f).

sulphureus Palisot de Beauvois (partim), equals *Chlorotabanus crepuscularis.*

84. *superjumentarius* Whitney, 1879, Canad. Ent., **11**:37. Cotypes, 2♀♀, Milford, N.H.; destroyed. Hine, 1903, Ohio State Acad. Sci. Spec. Pap., **5**:55 (♂). Bequaert, 1933. Boston Soc. Nat. Hist. Occ. Pap., **8**:87. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 99 (f). N.H., *Conn., *R.I., N.Y., N.J., Del., *Pa., Md., Va., N.C., *Ga., Ohio.

Tabanus suberjumentarius Surcouf, 1921, Gen. Insec., Fasc. 175, p. 85 (lapsus).

susurrus (Marten), see *Hybomitra.*

tarandi Walker, equals *Hybomitra zonalis.*

tectus Osten Sacken, equals *sulcifrons.*

tener Osten Sacken, equals *rufofrater.*

tenessensis (Bigot), equals *molestus.*

terrae-novae Macquart, equals *Hybomitra zonalis.*

tetricus (Marten), see *Hybomitra.*

85. *tetropsis* Bigot, 1892, Mem. Soc. Zool. Fr., **5**:681. Type, ♂, Ga.; B.M.N.H. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 167, (unrecognized species of *Stenotabanus*).

86. *texanus* Hine, 1907, Ohio Nat., **8**:228. Cotypes, ♂, ♀, Galveston; Ohio S.U. Philip, 1936, Ohio Jour. Sci., **36**:155. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 70 (f). Tex., [Mexico?].

Tabanus costalis Bellardi, 1859, Saggio ditter. messicana, I, p. 63; not Wiedemann, Auss. zweifl. Ins., I, p. 173.
thoracicus Hine, see *Atylotus*.
tingaureus Philip, equals *Atylotus incisuralis* subsp.
trepidus McDunnough, see *Hybomitra*.

87. *trijunctus* Walker, 1854, List V, Sup. 1, p. 182. Cotypes, 2♀♀, Fla.; B.M.N.H. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:432. Mosier and Snyder, 1918, Proc. Ent. Soc. Wash., **20**:120 (eye colors). Philip, 1936, Bull. Brooklyn Ent. Soc., **31**:195 (♂). Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 107 (f). Fla., Ala., [Bahama Islands].

Tabanus rijunctus Mosier and Snyder, 1918, l.c., p. 122 (lapsus).
triligatus Walker, equals *Hybomitra affinis*.

88. *trimaculatus* Palisot de Beauvois, 1807, Ins. rec. en Afr. et en Amer., p. 56 (f). Type, ♀, North America; collection unknown. Wiedemann, 1828, Auss. zweifl. Ins., **1**:137. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:439 (♂, synonymy). Hine, 1903, Ohio State Acad. Sci. Spec. Pap., **5**:55; 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 58 (f). Marchand, 1918, Trans. Amer. Ent. Soc., **44**:175 (f). Philip, 1931, Minn. Exp. Sta. Tech. Bull. No. 80, pp. 30, 117 (l, pf). Que., Mass.?, Conn., N.Y., N.J., Pa., Del., Md., D.C., Va., N.C., S.C., Ga., Fla., Miss., La., Tex., *Okla., Ark., *Ky., Ohio, *Mich., Ill., Minn., Kan., Neb.

Tabanus aestuum Bosc (MS) by Macquart, 1838, Dipt. exot. nouv. peu connus, 1, p. 142.
Tabanus quinquelineatus Macquart, 1834, Hist. Nat. des Ins., Dipt., **1**:200. Type, ♀, Ga.; collection unknown, orig. in Percheron Coll.
trispilus Wiedemann, see *Hybomitra*.

89. *turbidus* Wiedemann, 1828, Auss. zweifl. Ins., **1**:124. Type, ♀, Ky.; Vienna Nat. Mus. Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:430; 1878, Smithsn. Misc. Collect. No. 270, p. 228. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 112 (f). Philip, 1941, Canad. Ent., **73**:107 (redescribes ♂). Ky., N.C., Ga., Fla., *Miss., La., Ark.

?*Tabanus fusconervosus* Macquart, 1838, Dipt. exot. nouv. peu connus, I, pt. 1, p. 147, (orig. Mem., Lille, 1838, p. 151). Type, ♀, "patrie inconnue"; collection unknown, orig. Paris Museum.
typhus Whitney, see *Hybomitra*.
unicolor Macquart, equals *rufofrater*.
uniformis Hine (not Ricardo), equals *equalis*.
utahensis Rowe and Knowlton, equals *Atylotus incisuralis* subsp.
validus Wiedemann, equals *atratus*.
variegatus Fabricius (not Degeer), equals *sulcifrons*.

90. *venustus* Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:444. Cotypes, ♂, ♀, Dallas, Tex. (lectotype, ♀, Stone, 1938); M.C.Z. No. 4038. Hine, 1903, Ohio State Acad. Sci. Spec. Pap., **5**:56; 1904, Ohio Nat., **5**:244; 1907, La. Agr. Exp. Sta. Bull. No. 93, p. 58 (f). Schwardt and Hall, 1930, Ark. Agr. Exp. Sta. Bull. No. 256, p. 26. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 78 (f). Ohio, *Ill., Ia., Kan., Okla., Mo., Ark., La., Tex.

vicarius Walker (partim), equals *lineola* and *quinquevittatus*.
vicinus Macquart, see *Hybomitra*.
villosulus Bigot, equals (?) *Apatolestes similis*.

90a. *vitliger* subsp. *nippontucki* Philip, 1942, Psyche, **99**:31 (♀). Type, ♂, Coachella, near Salton Sea, Calif.; U.S.N.M. No. 56087. Calif., Ariz.

90b. *vittiger* subsp. *schwardti* Philip, 1942, Psyche, **99**:29 (♀). Type, ♂, Knoxville, Tenn.; Coll. Philip. Mass., *N.J., Del., D.C., Md., Va., Ga., Fla., Miss., Tenn., Ohio, *Mo., *Okla., Kan., Ark., *La., Tex., N.M.?, Ariz.

vivax of authors (not Osten Sacken), equals *fairchildi*.

91. *vivax* Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:446. Cotypes, 2♂♂ (lectotype, Trenton Falls, N.Y., Stone, 1938); M.C.Z. No. 4042. Stone, 1938, U.S.D.A. Misc. Publ. No. 503, p .67 (synonymy). Female, see *arborealis* below. Que., N.F., N.S., Me., Vt., Mass., N.Y., N.J.

Tabanus arborealis Stone, 1935, Proc. Ent. Soc. Wash., **37**:14 (f). Type, ♀, Rutland, Vt.; U.S.N.M. No. 50617.

92. *wiedemanni* Osten Sacken, 1876, Mem. Boston Soc. Nat. Hist., **2**:455. Type, ♀, Enterprise, Fla.; M.C.Z. No. 4045. Osten Sacken, 1878, ibid., 2 (sup.) p. 559. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 91 (f). Male unknown. N.C., Ga., Fla., ?Ky.

?*Tabanus palpinus* Palisot de Beauvois, 1813-20, Ins. rec. en Afr. et en Amer., p. 221 (f). Type, ♂, United States; collection unknown.

Tabanus ater Wiedemann, 1828, Auss. zweifl. Ins., **1**:136. Cotypes, ♂, ♀, Savannah, Ga.; presumably Mus. Lille. Not Rossi, 1790, Fauna Etrusca, **2**:320; not Palisot de Beauvois, 1813-20, Ins. rec. Afr. Amer., p. 161 (f).

wrighti Whitney, equals *Hybomitra hinei* subsp.

zonalis Kirby, see *Hybomitra*.

zygotus Philip, see *Hybomitra*.

93. *zythicolor* Philip, 1936, Ohio Jour. Sci., **36**:152 (♂). Type, ♀, Oakdale, N.C.; Coll. Philip. Stone, 1938, U.S.D.A. Misc. Publ. No. 305, p. 69 (f). Va., N.C., S.C., Ga., Fla., Ala., *Miss., La., Okla., Tenn.

Fossil Tabanidae

Tabanus hipparionis Cockerell, 1909, Bull. Am. Mus. Nat. Hist., **26**:67-68 (f). Type, sex ♀, Florissant, Miocene horizon; AMNH No. 40959.

Tabanus merychippi Cockerell, 1916, Proc. Nat. Mus., **51**:96. Type, ♀?, Florissant Miocene horizon; U.S.N.M. No. 61993. Melander, 1946, Psyche, **53**:43 (allotype ♂, transfer to *Silvius*).

Tabanus parahippi Cockerell, 1909, Bull. Am. Mus. Nat. Hist., **26**:67 (f). Type, ♂, Florissant, Miocene horizon; A.M.N.H. No. 40959.

ADDENDUM: The article by P. W. Fattig listing the Tabanidae of Georgia (Emory University Museum Bulletin No. 4, 26 pp.) was received too late to make changes in proof of the Catalog. New records for the state include: *Chrysops—carbonaria, cuclux, divisa, fulvistigma* var. *dorsopunctata, germinata* var. *impuncta, hyalina, inda, lateralis, nigribimbo, parvula, sackeni, shermani,* and *striata; Stonemyia—rasa* and *tranquilla; Goniops chrysocoma; Chrysozona punctulata; Agkistrocerus megerlei; Microtabanus pygmaeus; Atylotus—thoracicus* and *bicolor; Hybomitra typha; Tabanus—bishoppi, fuscicostatus, vittiger* var. *scutellaris* (?*schwardti*), *nivosus, recedens, stygius,* and *trijunctus*. Twenty-nine other species have been starred (*) as new records in the Catalog which are listed by Fattig.

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ROCKY MOUNTAIN LABORATORY,
HAMILTON, MONTANA.

Mosquitoes of a Limited Area in Southern Mississippi

Charles D. Michener

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Introduction

It is the purpose of this paper to list the mosquitoes observed during about thirty consecutive months (including three summer seasons) of intensive mosquito collecting and survey work in and near Camp Shelby, Mississippi, and to provide data on the seasonal abundance and bionomics of these insects. This work was carried on by the United States Army to provide data for mosquito control activities. During the period mentioned above the collecting and survey work was continued throughout the year by interested persons and the survey methods remained the same. It is therefore believed that the collection data obtained in different seasons are comparable.

Of the fifty-two species of mosquitoes known from Mississippi, forty-seven were found at Camp Shelby.

Acknowledgements are due to Lt. Col. Herbert Spencer, who in large measure developed the mosquito survey program at Camp Shelby, to Mr. Wm. V. Reed, who helped to maintain the continuity of the program in spite of changes in military personnel, to Capt. Basil G. Markos and others who assisted in the collecting and carried on the collecting program prior to my arrival at Camp Shelby, and to Maj. James Sampson, Capt. Henry J. Graeser, and Capt. Walter M. Franklin who made the author's work in this study possible during eighteen months at Camp Shelby. The Fourth Service Command Laboratory has, since early in 1943, examined all specimens and checked the identifications. Thanks are also due my wife, Mary H. Michener, for much assistance in the preparation of this paper.

Location.—Camp Shelby is about ten miles southeast of Hattiesburg, Forrest County, Mississippi. The area regularly surveyed for mosquitoes is roughly rectangular, about seven miles long and three and one-half miles broad (24½ square miles). The few notes based on observations made outside this area are indicated as such.

Topography.—Much of Camp Shelby lies on gently rolling, relatively high ground (220 to 300 feet above sea level), for the most part along the divide between streams flowing to the north directly into the Leaf River and those flowing to the south into Black Creek. This high ground is covered with a rather poor second growth of long-leaf and other pines intermixed with oak but with little underbrush.

The stream valleys, however, support a dense growth of trees such as red gum and bay. Those that have not been cleared are thick with underbrush and vines. These riparian forests are restricted in the higher areas, since the stream valleys there are small. To the south the land slopes away very gradually and the valleys become broad, swampy, densely wooded areas, flooded with each heavy rain. They thus provide large mosquito breeding areas. The streams flowing north are quite different in character, for the southwestern edge of the Leaf River valley is in this region marked by a rather steep bluff, north of which lies low swampy land, little over 100 feet above sea level, adjacent to the Leaf River. Streams running northward rush down the bluff forming rather deep canyons; indeed the entire bluff is a maze of densely wooded canyons. In this area the streams flow rapidly enough that few mosquito breeding places exist.

The flat lowlands along the Leaf River are very different from the rest of the region near Camp Shelby, and different mosquito problems are encountered there. The Leaf River, even at low water, is a broad flowing stream. Its banks are for the most part sandy, and there is very little vegetation in the water. Thus the river itself does not provide mosquito breeding areas. It has, however, changed its course from time to time so that there are several ox-bow lakes near the river. The newer of these lakes contain water-lilies and other herbaceous aquatic vegetation, while the older ones are partially or completely shaded in summer by forests of cypress and other large trees growing from the lake or swamp floor. Although the lowlands adjacent to the river are covered with a dense forest of large trees, such as magnolia, sweet gum, sycamore, and beech, they are flooded at highwater periods, which occur chiefly during the winter and spring. The water among the trees, or perhaps the river bed itself in its wanderings, has produced numerous large channels and depressions, four to six or even ten feet in depth; in some cases these are elliptical or circular and as much as sixty feet in diameter, in other cases twenty to one hundred feet wide and hundreds of yards in length. Dark brown water shaded by the trees remain in these depressions until late summer or even throughout the season.

Soil.—Probably the most important factor affecting mosquito abundance is permeability. The soil in many places contains sand and gravel and is sufficiently permeable that puddles of water will not remain for more than a day or so following a rain. In other areas similar puddles remain for a week or more and serve as breeding places for certain species of *Aedes* and *Psorophora*. In certain places where clay is close to the surface water remains almost indefinitely in foxholes and other pits.

Along the streams and in the swamps other than that along the Leaf River the soil is frequently a soft, water-soaked black muck, with tangled roots near the surface. There are numerous spring head areas, especially near the sources of the various streams, which are always wet even after a long dry period of weather. In most parts of the camp, however, the water table is below the ground surface. The soil of the lowlands along the Leaf River consists of river-washed sand and gravel. Water probably remains in depressions there chiefly because of the high water table.

Artificially Produced Mosquito Breeding Places.—Foxholes and other pits and trenches have already been mentioned. They can be found in many parts of the post, although they hold water only in certain areas. Three railroads enter the surveyed area and numerous roads have been built in the camp. Embankments for these roads and railroads have at several points allowed water to collect and stand. Old tin cans and bottles frequently collect water and serve as breeding places for mosquitoes. Short sections of a few streams are polluted from septic tanks. As a result puddles along their margins breed great numbers of *Culex quinquefasciatus,* although if unpolluted these same puddles would produce few mosquitoes. Laundry waste considerably affected the mosquito fauna of one stream.

Climate.—The accompanying temperature and rainfall data were compiled from United States Weather Bureau records obtained near Hattiesburg. The average annual rainfall for a fifty year period at Hattiesburg is 58.28 inches.

In the following table the column "D. R." (days with rain) has been included because it was noted that the mosquito production was very different during weeks when, for example, a light rain replenished puddles every day from that during weeks when the same total amount of water fell, but all in a single day, the remaining days being dry. Rainfall during the summer comes largely in a series of local storms, so that while streams at one end of the camp may be in flood, those at the other end often have only normal flow. Hence the rainfall figures, particularly for the warmer months, are not highly significant, since they were taken more than ten miles from Camp Shelby. Rains during the cooler months are general storms which may last for days, thus keeping many puddles full long enough to serve as breeding places for certain mosquitoes.

Because of such factors as these the tables of mosquito collections cannot for the most part be easily correlated with similar tables showing weekly rainfall or other climatic factors. The temperature and rainfall data, therefore, have been combined into a single table.

In the column headed "Tot. Rain" (total rain) certain weeks will be seen to be marked with leaders rather than any figure. In such weeks some rain fell, as shown by the days with rain column, but less than 0.05 inches. so that when the figure was carried out to but one decimal place it would read zero.

TABLE 1.—Climatological Data.

		1942						1943						1944					
		Tot. Rain	D. R.	Av. Max.	Av. Min.	Max.	Min.	Tot. Rain	D. R.	Av. Max.	Av. Max.	Max.	Min.	Tot. Rain	D. R.	Av. Max.	Av. Min.	Max.	Min.
Jan.	1							2.4	3	65.7	34.6	77	27	2.9	2	52.1	33.4	67	28
	2							0.2	2	65.7	37.4	82	28	1.8	4	53.3	30.4	61	19
	3							0.2	3	71.7	45.3	82	18	0	0	64.9	30.1	71	26
	4							0.4	3	63.7	40.3	81	29	0.5	3	71.4	53.4	76	40
	5							3.5	3	73.4	49.0	80	36	0.6	2	71.4	43.3	76	35
	6							0.1	1	68.6	36.4	79	26	0.4	3	65.3	42.6	78	25
Feb.	7							0	0	63.1	28.3	75	19	1.5	7	64.0	45.4	79	29
	8							0.4	1	72.3	43.6	81	25	2.1	4	80.7	63.3	82	60
	9							2.4	5	58.1	35.3	68	17	0	0	73.7	47.4	82	34
Mar.	10							0.2	2	70.3	43.9	83	27	0.4	3	68.6	46.0	84	34
	11							6.5	4	78.1	54.6	83	41	2.4	3	76.4	55.3	84	45
	12							1.7	1	65.6	45.0	74	34	4.0	3	66.4	49.0	80	43
	13							3.1	1	79.3	48.7	82	43	4.2	3	73.3	45.3	82	34
	14							1.8	2	82.7	55.0	87	42	0.5	2	70.1	46.4	77	34
	15							.....	3	78.7	50.6	87	35	0.3	4	79.1	56.4	86	43
Apr.	16							1.7	3	75.1	48.6	83	39	1.2	5	78.3	62.4	85	49
	17	0	0	85.2	60.6	90	53	0	0	87.4	55.7	93	49	4.2	3	76.9	55.9	80	49
	18	0.1	1	84.7	61.3	88	55	0.2	1	90.3	61.6	93	54	1.7	2	77.1	55.4	84	43
	19	8.1	4	83.0	56.3	86	45	0.8	1	87.3	62.7	91	57	0	0	84.4	57.0	89	48
	20	0	0	83.6	58.0	89	50	0	0	90.4	64.3	94	61	1.0	1	90.1	64.7	93	61
May	21	0	0	87.3	61.0	91	54	1.5	3	87.7	64.0	93	54	1.6	5	85.9	66.6	88	64
	22	0.6	3	88.6	65.5	93	61	.....	2	91.6	70.4	95	67	1.3	1	88.7	67.7	90	66
	23	3.4	6	86.3	70.4	92	67	1.0	2	94.6	68.7	98	67	1.2	2	90.9	66.7	93	60
	24	0.5	4	89.9	70.0	93	67	0.4	4	95.3	69.4	98	67	0.8	1	91.7	72.4	95	64
	25	0.8	4	88.4	68.4	93	65	1.5	5	92.3	69.4	95	68	0	0	96.4	73.6	99	70
Jun.	26	1.5	4	89.4	69.9	94	69	1.5	4	91.0	71.1	94	69	1.4	4	91.3	67.9	97	63
	27	0.6	3	88.4	71.9	93	70	0	0	96.6	68.1	100	65	0.3	2	88.9	67.9	97	65

TABLE 1.—Climatological Data (Continued).

TABLE 1.—Climatological Data (Continued).

		1942						1943						1944					
		Tot. Rain	D. R.	Av. Max.	Av. Min.	Max.	Min.	Tot. Rain	D. R.	Av. Max.	Av. Max.	Max.	Min.	Tot. Rain	D. R.	Av. Max.	Av. Min.	Max.	Min.
Jul.	28	1.4	2	92.6	71.9	96	69	1.8	3	88.9	70.7	96	69	0.5	4	93.4	72.0	98	71
	29	0.3	3	92.7	71.1	97	68	0.1	1	97.9	72.6	104	71	.....	1	96.9	70.0	102	64
	30	2.1	4	89.6	69.4	94	67	0.7	5	92.1	73.1	97	71	0.8	2	96.9	70.7	100	68
Aug.	31	0.9	4	91.3	69.0	94	65	1.3	2	92.6	74.0	97	73	1.7	6	90.1	70.4	98	66
	32	0.2	2	88.3	68.3	94	65	2.7	2	93.1	74.3	96	72	2.0	5	89.1	71.0	95	70
	33	4.4	4	89.3	70.4	95	69	0.2	2	92.4	68.4	99	59	0.7	1	91.0	71.0	93	69
	34	1.2	4	88.4	68.7	92	62	.....	1	95.3	68.0	101	63	2.4	6	90.1	70.7	93	68
	35	0.6	2	86.6	66.9	89	64	1.5	5	90.7	72.4	95	70	2.0	5	88.1	71.1	92	68
Sep.	36	1.2	5	90.0	68.7	91	65	0.9	3	87.6	64.0	89	51	2.9	4	85.6	69.4	93	61
	37	2.5	5	85.6	68.1	91	64	1.7	2	83.7	63.1	92	59	0.3	2	84.1	62.0	88	57
	38	0	0	82.3	57.3	91	47	4.2	3	78.0	60.6	83	53	0.4	2	87.7	67.3	91	62
	39	0.4	1	76.3	51.3	83	45	0	0	81.1	60.9	85	55	1.7	3	84.7	68.8	87	68
	40	0.1	2	82.6	54.0	88	45	0	0	80.1	54.1	86	48	0.8	2	82.4	66.3	86	60
Oct.	41	0	0	84.0	51.0	85	50	0.4	1	78.7	50.9	84	39	0	0	72.0	43.5	80	40
	42	0	0	83.0	54.9	88	51	0	0	79.4	44.4	84	32	0	0	77.7	44.0	83	40
	43	1.6	3	73.7	51.9	84	31	0	0	71.1	42.9	82	32	0	0	78.7	41.8	84	35
	44	1.9	2	74.6	49.3	79	41	.....	1	77.0	51.0	82	36	.....	1	79.7	48.0	83	43
Nov.	45	.....	1	74.9	43.4	82	29	3.1	2	64.8	35.0	72	29	1.1	2	73.5	43.5	79	38
	46	0	0	78.1	47.3	82	29	0	0	69.0	34.1	74	27	3.0	2	70.0	50.7	76	44
	47	1.9	3	66.9	42.3	78	28	0	0	68.9	32.4	76	28	2.0	3	63.2	41.0	69	32
	48	0.6	4	71.6	40.6	78	27	1.4	5	64.9	43.7	69	29						
	49	0.9	3	59.3	38.6	76	30	0.1	3	78.0	54.4	80	44						
	50	0.8	1	65.6	38.6	76	30	1.7	2	50.4	26.6	64	17						
Dec.	51	1.6	3	69.4	42.3	80	34	0.9	4	59.1	33.7	71	22						
	52	4.6	2	60.7	46.8	75	35	1.1	3	51.0	38.1	61	27						

Tot. Rain = total rain in inches; D. R. = days with rain; Av. Max. = mean of maximum temperatures; Av. Min. = mean of minimum temperature; Mx. = maximum temperature; Mn. = minimum temperature. Temperatures are in degrees F.

Mosquito Survey Methods.—Each week for thirty months a crew of from three to six enlisted men and, during most of the period, a civilian entomologist, under the direction of a Sanitary Corps officer, covered the entire regularly surveyed area, dipping for mosquito larvae in all standing water. Approximately the same number of dips was made in a given body of water each time it was visited. Records were made of actual numbers of larval specimens collected for each species; using merely the number of collections of a species was found to be less reliable as a criterion of the abundance of the larvae.

Three survey methods were used to provide data for estimating the relative abundance of adult mosquitoes at different places and at different times.

Four New Jersey type mosquito traps were operated each night. The locations of these traps remained the same throughout the period of study. Mosquitoes were removed from the traps either daily or three times a week, but in either case the entire catch for seven days a week was counted.

Numerous mosquito resting stations were utilized. These included culverts, barrels, hollow stumps, privies, and other dark protected places where adult mosquitoes of certain species spend the day. The mosquitoes in each of these stations were collected once each week.

Seven localities were designated as biting stations. One of these, located in the lowlands adjacent to the Leaf River, was used to give an indication of the abundance of diurnal woodland mosquitoes and was visited only by day. Every week during the warmer part of the year each of the others was visited by one man at dusk. The man at each station remained there approximately an hour and collected all mosquitoes attracted to him. Because of irregularities in weather, this method is of little value in indicating fluctuations in mosquito abundance.

No one of these survey methods is adequate in itself, since different mosquitoes are best obtained in different ways. For example, *Culex apicalis* is not strongly attracted to light-traps or the usual resting stations and apparently does not bite man. Larval collections offer the only easy means of determining the variations in abundance of such a species.

The following figures show the number of specimens collected and identified: For 1942 (32 weeks only, 10,829 adults, 5,761 larvae; for 1943, 8,400 adults, 11,739 larvae; for 1944 (43 weeks only), 8,795 adults, 12,434 larvae. Over 28,000 adults and nearly 30,000 larvae were collected in all. These figures are for specimens actually collected. Many more were observed and notes often taken concerning abundance of specimens too numerous to collect.

Tabulations.—For all except the rarer species tables have been prepared to show the seasonal fluctuations in collections. Collecting data will be found in the text for the actually rare species and for some others, collections of which are scattered and follow no definite pattern.

In making the tables for this paper, data which are possibly inaccurate have been entirely omitted. Thus, collection data for *Culex restuans* and *Culex quinquefasciatus* are not given for 1942 since there is a probability that there was some confusion of these species in that year. Except for the species of *Anopheles*, adequate data is not available prior to the twenty-first week of 1942.

Specimens obtained by irregular and occasionally used methods are not included in the tables but are not mentioned in the text.

It is interesting that several of the tables (e.g. *Culex restuans*) show large collections of larvae during the spring with no comparable large adult collections, although in the fall adults were often obtained in larger numbers than larvae. The reason for this is not clear, but it appears that, for several species of mosquitoes, spring weather conditions are less favorable for large light-trap catches than fall weather conditions.

Control Program.—It was the purpose of this survey to provide information for use in the mosquito control program. Much, but not all, of the regularly surveyed area was within controlled area. Observations outside of the control area, and also outside of the regularly surveyed area, indicate that the fluctuations in mosquito numbers outside of the controlled area are similar to those within, although, of course, the numbers of individuals are smaller in the control area. Therefore it is believed that the tabulations in this paper would not appear greatly different had the observations been made in an uncontrolled area.

Associated Species.—It is useful to correlate mosquito species with distinctive ecologies or behavior patterns, as follows:

1. Species which have been observed biting man more or less frequently at and near Camp Shelby: *Aëdes atlanticus, Aëdes sticticus, Aëdes triseriatus, Aëdes vexans, Anopheles punctipennis, Anopheles quadrimaculatus, Culex quinquefasciatus, Culex salinarius, Psorophora confinnis, Psorophora ferox, Psorophora horrida, Psorophora varipes.*

2. Larvae commonly associated with *Anopheles quadrimaculatus* (If any of these are found in a pool, extensive search for *quadrimaculatus* is worthwhile): *Anopheles crucians, Culex erraticus, Uranotaenia lowii, Uranotaenia sapphirina.*

3. Larvae found only in tree-holes and in small artificial containers situated in the shade and partially filled with decaying leaves or other organic matter: *Aëdes triseriatus, Anopheles barberi, Megarhinus septentrionalis, Orthopodomyia alba, Orthopodomyia signifera.*

4. Larvae found regularly in small, often sunlit artificial containers of water: *Aëdes aegypti, Culex quinquefasciatus, Culex restuans* (?).

5. Species whose larvae often occur in polluted water: *Culex quinquefasciatus, Culex restuans.*

6. Larvae found chiefly in temporary pools left by river flood waters: *Aëdes cinereus, Aëdes sticticus, Psorophora ferox, Psorophora horrida, Psorophora varipes. Aëdes vexans* is also common in such situations.

7. Larvae found chiefly in strictly temporary sunlit rainwater pools:

Aëdes vexans, Culex pilosus, Psorophora ciliata, Psorophora confinnis, Psorophora discolor, Psorophora howardii.

8. Species whose larvae are predaceous, chiefly on the larvae of other mosquitoes: *Megarhinus septentrionalis, Psorophora ciliata, Psorophora howardii.*

9. Species which are more abundant in winter than in summer: *Culex restuans, Culiseta inornata.*

10. Species which are more abundant in spring and fall than in winter or midsummer: *Anopheles punctipennis, Culex salinarius.*

11. Species which pass the winter chiefly as more or less quiescent adult females: *Anopheles crucians, Anopheles punctipennis, Anopheles quadrimaculatus, Culex erraticus, Uranotaenia sapphirina.*

12. Species which continue breeding during the winter and thus may be found in all stages during the winter: *Aëdes canadensis?, Aëdes vexans Culex apicalis, Culex quinquefasciatus, Culex restuans, Culiseta inornata, Culiseta melanura. Anopheles crucians Anopheles punctipennis,* and to a lesser degree *Anopheles quadrimaculatus* might also be placed here, although perpetuated during the winter chiefly by quiescent females.

13. Species which apparently pass the winter chiefly, if not entirely, as larvae: *Megarhinus septentrionalis, Orthopodomyia signifera.*

14. Species which probably pass the winter in considerable numbers both as eggs and as larvae: *Aëdes canadensis, Aëdes triseriatus, Aëdes vexans.*

15. Species which presumably pass the winter as eggs which hatch in the spring: *Aëdes atlanticus, Aëdes mitchellae, Aëdes sticticus, Psorophora ciliata, Psorophora confinnis, Psorophora discolor, Psorophora ferox, Psorophora horrida, Psorophora howardii, Psorophora varipes.*

Discussion of Species

1. ANOPHELES (ANOPHELES) QUADRIMACULATUS Say

This mosquito is considered the most important malaria vector of the southeastern states.

In the daytime during the summer the adults may be found in cool, dark resting places such as culverts, under bridges, and in buildings, especially privies. They are much less strongly attracted to lights than many mosquitoes, but judging from the Camp Shelby records the light-trap catches provide a usable index to the abundance as judged by resting station catches. During the hot months of midsummer the trap catches ran far below the resting station catches, but, with the same traps and resting stations, the trap catches ran above the resting station catches during most of the cooler fall months. Perhaps there is less attraction to the damp, cool locations in the cooler months than during the hot months.

Since the light-trap catches consisted very largely of females, the light-trap curve, as might be expected, ran more nearly parallel to the curve for females from resting stations than to that for total *quadrimaculatus* from resting stations.

In culverts and similar resting stations this species very commonly hangs on spider webs. When on the walls it usually rests with its body at a smaller angle to the surface than is common with *crucians* or *punctipennis*. It is also more easily disturbed than the other species and therefore more difficult to collect in resting stations.

In localities where this species was abundant outside the regular control area, cubical boxes eighteen inches on a side with one side open were found to be satisfactory resting stations when nailed to trees in a thoroughly shaded place about four feet above the ground. The insides of these boxes were painted dark red. Even only moderately effective control measures rendered such boxes of little value, however, because of the small number of mosquitoes found in them.

Exceedingly few specimens of this species were collected by the standard survey methods during the winter. A female *quadrimaculatus* was taken resting in a privy on February 8, 1944, during a long period of warm weather and another February 16, in a light-trap, and a few larvae were collected, as indicated on the accompanying table, during various winter months. Most of the winter larvae were in a fish pond; natural collections of water are almost free from this species in winter in this locality. Adult females may, however, be collected at any time during the winter by spraying inside of large hollow trees with fly spray. A piece of paper in the bottom of the hollow will catch the falling mosquitoes. Specimens captured in this manner were not included in the graph. The species evidently overwinters in such places. Several days or weeks of warm weather appeared to be necessary to cause the emergence of the overwintering females (which average larger and more robust than summer forms) from the protected hollows. Other authors (e. g. Barber, 1924), however, record considerable winter activity for this species in the far south.

It seems quite possible that effective control of this species might be obtained by destroying all large hollow trees in an area or by spraying inside such trees in the fall with light fuel oil, which has been observed to repel mosquitoes from culverts for weeks. The mosquitoes would be left without adequate winter protection and would be killed by weather conditions in such inadequate shelters as they could find. Such work should probably cover an area extending several miles from the region to be protected, for spring and fall flights of the overwintering females are thought to be much longer than the usual summer flights.

Larvae of this species, as is well known, occur primarily in fresh, clear, sunlit water containing emergent vegetation or floatage. They were found in small numbers in many locations at Camp Shelby. Many seemingly favorable locations were consistently free from this species. In many areas at Camp

TABLE 2.—Specimens of *Anopheles quadrimaculatus* by weeks. Larval collections are shown in italics. No records are available for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.				Apr.				May					Jun.		
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																					5			20	6	14
1943							*15*														*1* 1	2	8	*1* 4	80	*1* 245
1944						1	2						1						1		2	2	4	3	16	34

	Jul.				Aug.				Sep.				Oct.					Nov.					Dec.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942	13	20	15	11	15	15	11	2	14	5	8	12	*3* 19	*24* 19	*2* 22	22	5	1		*2*			*2*			
1943	275	293	*33* 125	*1* 34	50	*3* 23	*4* 10	*3* 23	*2* 10	*7* 8	13	12	6	8	2	1		*2* 2	1							
1944	30	18	10	10	*22* 12	3	3	2		1	8	12	8	*2* 16	13	7	7	1	*2* 5	*3* 4	4					

Shelby pools of water are partly covered with a brown scum. This scum appears to prevent the breeding of *Anopheles*. Larvae of *quadrimaculatus* appeared to be always scarce under entirely natural conditions, but they were common in certain kinds of artificial pools and lakes. In water-filled pits along a railroad track they were rather abundant. In a newly filled artificial lake containing much floatage about three miles from Camp Shelby this species was exceedingly abundant during the latter part of August and the entire month of September, 1943. Along the margin (chiefly in isolated ponds but little affected by the lake level) as many as twenty or twenty-five *quadrimaculatus* larvae were obtained in a single dip. During October this species was gradually replaced by *punctipennis,* and by November all *Anopheles* larvae obtained there belonged to the latter species. By February 5, 1944, about 95 per cent of the larvae in these same ponds were *crucians*. During the summer of 1944 larvae of *crucians* were more abundant than those of *quadrimaculatus* in this lake.

Larvae of *quadrimaculatus* were found at Camp Shelby in a number of unusual situations during the summer of 1943 after a large influx of adults. All ordinary breeding places of this species in the area had been either oiled or drained. Several larvae were found at this time in water in foxholes (lacking vegetation or floatage), in completely shaded puddles, etc.

The months of maximum collections and presumably maximum abundance of this species differed markedly in the three seasons covered by this study, as shown in table 2. It is suspected that the 1942 picture is the more usual, since the abundance of this species in the fall correlates well with the usual fall maximum malaria incidence.

In 1943, however, adults were not collected until the twenty-first week in spite of weather during preceding weeks warmer than in comparable weeks of 1942. From the middle of June through July, this species was exceedingly abundant, collections reaching a peak on the twenty-eighth week more than nine times as high as the maximum for the preceding year. The number of specimens collected decreased through the fall instead of increasing during September and October as in 1942 and 1944.

The great abundance of this species during midsummer and the absence of the autumn peak in 1943 cannot be satisfactorily explained at present. It is possible that the quite consistently higher temperatures during 1943 than in 1942 produced this difference.

It is interesting to consider the source of the many adult *quadrimaculatus* found within the controlled area at Camp Shelby during the midsummer period of abundance in 1943. Particularly at first there were few males among these mosquitoes, and because of control measures in some areas and unfavorable environmental factors in others, it seems certain that very few of the *quadrimaculatus* could have come from a distance of less than two miles.

A possible breeding place of *Anopheles* in such an instance when few or no larvae can be found is very shallow water. Here it is impossible to use a

TABLE 3.—Specimens of *Anopheles crucians* by weeks. Larval collections are shown in italics. Larval records for 1942 omitted. No records are available for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.				Apr.				May					Jun.			
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																		11			33	21	5	26	71	51
1943					*5*						*2*		*13*	*23*	*20*	*8*	*11*	*4*		*17*	*22*	*12*	*10*		*1*	*1*
	1	2	3							1			3	7	8	6	11	7	11	21	20	4	13	15	22	30
1944										*3*												*3*			*7*	*2*
						1	1	1	3	1	7	3		4	6	7	5	26	5	8	13	2	54		33	73

	Jul.					Aug.				Sep.				Oct.				Nov.					Dec.			
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942																										
	43	35	21	34	22	13	18	48	14	40	68	43	26	14	19	12	7	8	1	9	1	2			7	4
1943			*6*			*3*																				
	38	9	3	7	3		1	1		1		3	3		6	1	2	3	3	2		2	2			
1944		*13*	*28*		*2*						*2*		*2*	*2*			*1*		*1*	*1*						
	2	2	3	8	3						12	3	4	11	16	12	12	4	4	2						

dipper to collect larvae and the use of a pipette is exceedingly laborious. However, on one occasion (July, 1944) many *quadrimaculatus* larvae were found in fifty square feet of water about one-quarter of an inch deep which covered the concrete end platform of a culvert. Larvae in similarly shallow natural collections of water would be very difficult to find.

Three larvae apparently of this species, collected in October, 1944, were peculiar in having the inner clypeal hairs two- or three-branched near the tips. Otherwise these specimens were typical of *quadrimaculatus* and clearly did not belong to *atropos* or *walkeri*, species in which the inner clypeals are normally branched.

2. ANOPHELES (ANOPHELES) CRUCIANS Wiedemann

The adults of this form are apparently indistinguishable from those of *georgianus*, although the larvae are clearly distinct. The accompanying data for adult collections and discussion of adults pertain, therefore, to both species.

The status of *georgianus* (and the coastal representative of this complex, *bradleyi*) as subspecies of *crucians* is a matter of question. The names *georgianus* and *bradleyi* were proposed as varieties of *crucians*. Later (see King, Bradley, and NcNeal, 1942) they were considered as separate species. Ross and Roberts (1943) consider them subspecies of *crucians*. It appears that, in view of the lack of intergradation between the three forms in the rather striking larval characters, they are best considered separate species. The geographical ranges of *bradleyi* and *georgianus* are included within the range of *crucians*. The larvae, however, occur in different ecological situations. About half of the adult females of *bradleyi* have more white wing scales than do the other forms. Otherwise adults of the three forms do not seem to differ, except for inconspicuous and intergrading characters of the male genitalia.

As with *quadrimaculatus*, this species in summer can be obtained in large numbers in appropriate resting places but is collected only in limited numbers in light-traps. In resting *crucians* stands at a large angle, sometimes nearly 90°, to the surface. This is particularly true of males and of females which have not recently fed.

An adult male, presumably freshly emerged from the pupa, was collected in a resting station (culvert) on February 10, 1944, during warm weather. Apparently some breeding and larval growth continues during the winter months. Mature larvae were collected at a point about three miles from Camp Shelby on February 5, 1944.

In studying the table of collections of adults of this species in 1942 and 1944 as compared with that of 1943, a parallelism can be observed between this species and *quadrimaculatus*. In 1942 and 1944 the catch of both species shows a fall peak which is scarcely noticeable in 1943. In both species the chief 1943 peak was on the twenty-seventh or twenty-eighth week of the year. The midsummer peak of *crucians* in 1943, however, was low compared with that of *quadrimaculatus*. Possibly the same environmental factors control the abundance of the two species.

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TABLE 4.—Specimens of *Anopheles georgianus* larvae by weeks. No records are available for 1944 after the forth-seventh week.

	Jan.					Feb.				Mar.				Apr.				May				Jun.			
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																				7		6	8	5	4	2
1943														5	9		5		5	2	4	10	2	4		
1944							3																2			

	Jul.				Aug.				Sep.				Oct.				Nov.				Dec.				
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942	1	23	2	5	7																					
1943		2	4		8	1		1					6							1						
1944	4	3		4													8									

On June 28, 1944, nine third and fourth stage larvae of *crucians* were found in a stump hole in company with *Orthopodomyia signifera*. These larvae were reared in the laboratory in the stump hole water and normal adults emerged. On July 10, 1944, numerous fourth stage as well as small larvae of this species were found in rainwater standing in tar barrels. It is suspected that breeding in such unusual situations took place because normal breeding places in the area were oiled and repellent to female mosquitoes.

An interesting abnormal larva of this species was collected in November, 1944. The right inner clypeal hair was many times dichotomously branched, having the appearance of an outer clypeal hair. The left inner clypeal was normal, simple. The bases of the two dissimilar inner clypeals were widely separated as in *quadrimaculatus*. Otherwise the larva was a typical *crucians*.

3. ANOPHELES (ANOPHELES) GEORGIANUS King

The larvae of this species were taken on numerous occasions at Camp Shelby as shown in table 4. The adults, being apparently indistinguishable from those of *crucians*, were not recognized as *georgianus* except for a small series bred in May, 1942, from known *georgianus larvae*.

The larvae were usually found in shallow water in spring head areas. These areas were usually in the shade, with dead leaves and leaf mold under the water surface, and often with grass growing in thick clumps and partially covering the water surface. The water in such places had a low pH. Larvae were also taken several times in a heavily shaded pool full of decaying oak leaves which gave the water a brownish-black tint. Otherwise apparently suitable waters which were covered with a brown film, perhaps of iron bacteria, were never found to contain larvae of this or any other species of *Anopheles*.

4. ANOPHELES (ANOPHELES) BRADLEYI King

A female specimen of this salt marsh representative of the *crucians* complex was taken in a light-trap on February 10, 1944, and another on February 28, 1944.

The remarks under *atropus* apply also to this species.

Since not all specimens of *bradleyi* are distinguishable from *crucians* and *georgianus*, a few of the records for adult *crucians* may be based on unrecognized specimens of *bradleyi*.

5. ANOPHELES (ANOPHELES) PUNCTIPENNIS (Say)

As with *quadrimaculatus* the adults of this species are not strongly attracted to light. They can be collected in considerable numbers, even in winter, in culverts, under bridges, in privies, and the like. Like *crucians* the adults when resting on a surface stand at a large angle (often nearly 90°) to the surface. This is especially true of males and unengorged females. The species bites man rather freely outdoors in the evening. During warm winter days they may occasionally bite in strong sunlight.

In winter, females of this species were collected in large hollow trees with *quadrimaculatus*. Apparently each warm day was sufficient to cause some individuals of *punctipennis* to fly about.

Larvae of *punctipennis* were collected regularly in a greater variety of situ-

TABLE 5.—Specimens of *Anopheles punctipennis* by weeks. Larval collections are shown in italics. Larval records for 1942 omitted. No records are available for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.				Apr.					May				Jun.			
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																						5	2	5	7	9
1943	*53*	*30*	*2*	*15*	*21*	*26*	*8*	*25*	*23*	*15*	*31*	*11*		*2*		*2*	*3*				*11*	*15*	*12*		*10*	*5*
	4	2		2	1	1				1						4			3							2
1944							*5*	*79*	*77*	*15*														*2*		
			5	1	2			1	2													2	2			

	Jul.				Aug.				Sep.					Oct.				Nov.					Dec.			
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942																										
	9	3	9	4	3		1			1		40	71	33	100	52	9	7	3	5	6	3	9	15	10	3
1943	*19*	*18*												*3*	*6*	*21*	*53*	*66*		*3*						
		1			3	3				.	16	24	16	7	7	2	6	5		20	20	47	11		2	3
1944	*2*	*2*		*5*							*7*	*1*	*9*	*20*			*13*			*11*						
												3	9	8	4	13	3	4	11	41	68					

ations than any other *Anopheles* found in this area. They were common, especially in summer, in quiet eddies and pools along streams. They occurred in water standing in artificial pits, indeed in standing clear water of almost any sort. Occasionally they were found in muddy water. While generally found among emergent vegetation or floatage in the water, this was not always the case. In October and early November of 1943, very many larvae of this species were collected. The reason for this abundance was a prolonged dry period during which many streams ceased to flow. The larvae lived in the resultant quiet ponds in the stream beds. Of course the first heavy storm destroyed most of them by flushing out the stream beds, but many had already emerged and are shown by the late November and early December peak in adult catches.

By February 15, 1944, numerous larvae were found in some ponds, particularly in the Leaf River area. Since no *punctipennis* larvae were found in these ponds during December or January, it is believed that they hatched from eggs laid during a long warm period in late January and early February. Some of these larvae reached the adult stage as early as February 20. Barber (1924) has shown that in both this species and *crucians* larval growth as well as egg laying and hatching and emergence of the adults takes place during the winter in the southern states.

6. ANOPHELES (ANOPHELES) ATROPOS Dyar and Knab

One female of this species was taken in a light trap on June 4, 1943.

So far as known *atropos* is confined in its breeding to coastal salt marshes, the nearest of which are over forty-five miles from Camp Shelby. It seems improbable that an *Anopheles* would fly such a distance. It is quite possible, however, that one would be carried in an automobile to a point near Camp Shelby and there escape and enter a light-trap. Mosquitoes of various kinds have frequently been observed in automobiles. Inland records of this and other salt marsh mosquitoes are given by Carpenter and Middlekauf (1944).

7. ANOPHELES (ANOPHELES) WALKERI Theobald

Seven adult female specimens of this species were taken in light traps at Camp Shelby as follows: two, May 8, 1942; one, June 16, 1942; two, July 20, 1942; one, June 11, 1943; and one, May 11, 1944.

8. ANOPHELES (ANOPHELES) BARBERI Coquillett

Some adults of this species were captured in light traps, others in dark daytime resting stations. Larvae were found in tree holes and in shaded tin cans or buckets partially filled with leaves and twigs decaying in the water. Adults were found May 5, June 26, July 6, and November 10, 1942, and July 5, 1944. An additional adult was collected on November 12, 1941. Larvae were collected on dates scattered from February 29 to September 17.

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TABLE 6.—Specimens of *Aëdes mitchellae* by weeks. Larval collections are shown in italics. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.					Apr.				May					Jun.		
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																					1	1				1
1943				*10*						1			*4*								1					
1944								1					1		3	7	8	13	1	2	2	2	2	3	2	

	Jul.					Aug.				Sep.					Oct.				Nov.					Dec.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942		2						*2*																		
1943								3	1						1	1										
1944			1		2	1		3	3	1		3	3	1	3											

9. AEDES (OCHLEROTATUS) SOLLICITANS (Walker)

This is a salt marsh mosquito which probably does not breed within about forty-five miles of Camp Shelby. Twenty-six specimens of the species, however, were caught in light-traps at Camp Shelby during 1942 and 1943. These may have been carried in by the wind, or perhaps, as may have been the case with *Anopheles atropos*, by automobiles. It seems probable that they arrived by natural means during the two weeks from June 13 to 26, 1942, in which period thirteen specimens were collected. At all other times not more than one or two were collected per week. Various inland records of this and other salt marsh mosquitoes are discussed by Carpenter and Middlekauf (1944).

Specimens were obtained on scattered dates from May 26 to September 29, with a single additional record for December 12, 1942. None were collected in 1944.

10. AEDES (OCHLEROTATUS) MITCHELLAE (Dyar)

This was an uncommon species at Camp Shelby but was collected throughout most of the year as shown in table 6. Most of the adults were in light-traps, although one was collected while biting at 10:00 a.m. on a cloudy day (February 28, 1944). The larvae were usually found in shallow, clear, partially shaded rainwater pools which hold water for at least moderately long periods and contain grass and other emergent vegetation. A few larvae of this species were collected on nearly every visit, except in midwinter, to one such location where water stands almost continually. These are not entered in the accompanying tabulation since they were obtained some two and one-half miles from Camp Shelby, outside the regularly surveyed area. Also not entered in the tabulation are numerous adults reared from pupae collected on April 6, 1944, in shaded pools containing no living vegetation but full of pine needles.

11. AEDES (OCHLEROTATUS) TAENIORHYNCHUS (Wiedemann)

This species, like *sollicitans*, is a salt marsh mosquito which probably does not breed in the vicinity of Camp Shelby. However, two females were collected in light-traps, one on August 15, the other on September 1, 1943.

12. AEDES (OCHLEROTATUS) INFIRMATUS Dyar and Knab

About ten adults of both sexes of this species were taken in light-traps on the following dates: September 16, 1941; May 8, June 20, July 1 and 18, 1942; and July 17, 1944. No specimens were collected in 1943. The genitalia of the 1944 specimen were examined in checking the identifiaction at the Fourth Service Command Laboratory.

13. AEDES (OCHLEROTATUS) DUPREEI Coquillett

Two larvae of this species were collected in a shallow, clear, partly shaded and grassy semipermanent pool on August 13, 1943. They were associated with numerous larvae of *atlanticus*. Other larvae were found on March 4 and May 24, 1944. Adults were collected in light-traps on June 15 and 26, July 2, 3, and 12, 1942; on September 19, 1943; and on September 8, 1944. The

TABLE 7.—Specimens of *Aëdes atlanticus* by weeks. Larval collections are shown in italics. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.				Apr.				May					Jun.			
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																					3	4	4	6	14	
1943																*12*										
1944													*5*	1							*2*		4			

	Jul.					Aug.				Sep.				Oct.				Nov.					Dec.			
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942		*3* 2	*1*	1				*1*			4															
1943						*75*						*1*	*1*	1	1											
1944									*5*	1	1															

identification of some of the males was corroborated by an examination of the male genitalia. Several adults were reared from pupae collected in a shaded woodland pool on May 30, 1944.

14. AEDES (OCHLEROTATUS) ATLANTICUS Dyar and Knab

This was a not infrequent daytime biter in wooded areas near Camp Shelby. Larvae were found in clear, shallow pools of water, which usually contained considerable grass or other vegetation. The few adults taken were biting or in light-traps. A few miles from Camp Shelby where adults were occasionally common it was noted that the females bite readily and severely by day and in light shade or even in the sun.

Table 7 shows the collecting records of this species.

15. AEDES (OCHLEROTATUS) THIBAULTI Dyar and Knab

A female of this species was collected on May 27, 1942.

16. AEDES (OCHLEROTATUS) CANADENSIS (Theobald)

Adults were obtained chiefly in light-traps but were not collected in nearly as large numbers as were larvae. Indeed, collections of adults were so meager that they are obviously not a suitable index of abundance of this species and have not been included in table 8. They range from early March to late July, with a single record for September, 1942. Even when very numerous this species was not a troublesome biter, only an occasional specimen being attracted to man.

The larvae were sometimes exceedingly abundant in water in pits, in small deep puddles along intermittent streams, and such places. Frequently they occurred in muddy water. In early spring they were also found in some of the temporary puddles which in midsummer produced *Aëdes vexans* and *Psorophora confinnis*. Larvae of *canadensis* in artificial pits were often found with *Culex restuans* and occasionally with *Culex apicalis*. In early February, 1944, larvae of this species were found in the receding flood waters of the Leaf River, associated with *Aëdes sticticus* and *vexans*, *Psorophora ferox*, etc. *Aëdes canadensis*, however, was not found after later spring floods.

17. AEDES (OCHLEROTATUS) STICTICUS Meigen

This species was an abundant and very troublesome mosquito biting in the woods by day and almost anywhere at night during the spring of each year. Adults were obtained from light-traps, but only rarely in culvert resting stations. A few specimens were collected in the fall in 1942 and 1943, in addition to the large numbers of spring specimens. Adults were serious pests for about two and one-half miles from their breeding areas in 1944, but at greater distances very few were seen. Because it flies considerable distances from the periodically flooded woodlands in which most of the breeding takes place, this species is much more troublesome than *Psorophora ferox* and *varipes* which

TABLE 8.—Specimens of *Aëdes canadensis* larvae by weeks. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.					Apr.				May					Jun.	
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																					*22*	*4*	*18*		*5*	*16*
1943	*43*	*15*	*33*	*31*	*20*	*4*		*24*	*20*	*4*	*48*	*95*	*178*	*100*	*40*		*15*					*23*			*2*	
1944		*7*	*20*	*115*	*195*	*156*	*197*	*241*	*385*	*388*	*96*	*180*	*193*	*189*	*2*	*46*	*43*	*9*	*2*			*24*	*25*			*15*

	Jul.					Aug.			Sep.					Oct.				Nov.						Dec.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942	*5*	*25*				*6*		*26*	*7*	*28*							*2*		*10*	*10*		*10*	*5*	*16*		*12*
1943			*29*			*13*		*10*			*2*	*22*	*8*													
1944	*3*	*4*					*16*		*6*																	

breed equally abundantly in the same wooded swamps but rarely leave these locations in large numbers.

In early March, 1944, numerous larvae and pupae were found in shaded pools left after high water of the Leaf River. These pools were also occupied by *Psorophora ferox, Psorophora varipes, Aëdes canadensis, Aëdes vexans,* and *Culex apicalis. Aëdes sticticus* apparently emerged from these pools very quickly so that its larvae disappeared before those of any of the other species. By March 8, but few larvae could be found and by March 14, onlv biting females of this species were seen. A few additional larvae were found in the same area after another high water in the last days of March. By April 6, all *sticticus* larvae had disappeared. On March 31, 1944, a few *sticticus* larvae were found in a rainwater pool near the Leaf River but well above high water level. Such small breeding places account for an extreemly small percentage of the spring specimens of this species, but it is no doubt in such locations that all summer and fall breeding takes place.

18. AEDES (OCHLEROTATUS) FULVUS PALLENS Ross

This is the *Aëdes bimaculatus* of authors, not Coquillett.

Six adults were collected at Camp Shelby. The dates are as follows: June 5, July 20, August 27, 1942; June 22, 1943; May 23 and September 13, 1944. At least those taken in 1943 and 1944 were in flight or resting on foliage in shaded woods when collected. The species does not appear to be easily obtained by the standard mosquito collecting methods. Larvae were not found at Camp Shelby.

19. AEDES (FINLAYA) TRISERIATUS (Say)

Although this species was common at Camp Shelby, the adults were rarely taken and have not been shown on the accompanying graph. They were observed to bite rather freely both by day and in the evening in woodland areas, but very few were found in light-trap catches and virtually none in the ordinary type of resting station. Occasionally they were found in hollow trees and on the walls of hollows containing water in which the larvae lived. Adults were collected from early April until October.

This species was the most abundant of the tree hole mosquitoes in the Camp Shelby area. Larvae occurred in company with those of *Megarhinus, Orthopodomyia,* and occasionally *Anopheles barberi.* Rarely except in winter was any one of these other tree hole mosquitoes found without *triseriatus* being present, although collections of water were often found containing the *Aëdes* but not the others. In addition to tree holes, the larval habitat includes water in tin cans, bottles, barrels, and the like if in shaded locations and containing decaying leaves. *Aëdes aegypti* occurs in similar receptacles, but these are often in the sun, free of decaying leaves, and generally near buildings. *Aëdes aegypti* and *triseriatus* were collected in the same receptacle but once at Camp Shelby.

TABLE 9.—Specimens of *Aëdes sticticus* adults by weeks. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.					Apr.				May					Jun.		
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																					21	10	10		1	
1943													1		19	26	27	18	10	13	18					
1944											6	50	19	29	61	409	180	108	3	146	94	68	60		2	

	Jul.					Aug.				Sep.					Oct.				Nov.					Dec.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942											1											1				
1943																							2			
1944																										

TABLE 10.—Specimens of *Aëdes triseriatus* larvae by weeks. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.				Feb.				Mar.				Apr.				May					Jun.				
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																						*12*	*18*	*6*	*8*	*18*
1943	*1*	*1*											*1*	*7*											*23*	*8*
1944	*4*		*2*	*1*	*16*	*31*	*35*		*30*	*9*	*2*	*3*	*25*	*19*		*5*	*14*	*20*	*1*			*21*	*28*	*33*	*11*	*14*

	Jul.				Aug.				Sep.				Oct.						Nov.						Dec.	
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942	*6*	*2*							*20*														*4*			
1943	*7*	*10*	*7*		*23*	*20*	*73*	*12*	*7*	*26*	*10*	*13*	*7*								*2*			*2*		
1944	*2*	*10*	*29*		*11*	*8*	*18*	*6*	*9*		*6*		*3*		*7*											

TABLE 11.—Specimens of *Aëdes vexans* by weeks. Larval collections are shown in italics. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan				Feb.				Mar.					Apr.					May					Jun.	
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																					*1* 16	*6* 10	*14* 3	41	16	*2* 45
1943	*16*	*7*	*16*	*15*		*6*		*15*	*2*	*2*	*3*	*13*	*18*	*6* 2	*6* 8	*10* 8	*6* 11	*5* 9	*6* 10	*19* 4	*94* 35	*2* 26	50	*18* 50	*16* 97	*3* 145
1944	*2*				*11*	*8*	*4*	*18*	*25* 5	*86*	15	*2* 81	*150* 15	*75* 5	14	*2* 79	*282* 27	*142* 21	*38* 5	32	*42* 10	*65* 10	*13* 26	*18* 4	14	9

	Jul.				Aug.				Sep.					Oct.					Nov.					Dec.	
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942	*3* 40	*7* 70	*4* 104	*4* 33	19	19	*22* 9	*43*	2	2	15	*14* 228	*10* 199	*15* 150	133	*3* 29	110	130	*6* 10	6	2	15	*3*	*2*		*8*
1943	*4* 45	*6* 19	6	21	*15* 12	*8* 8	*2* 43	*7* 66	16	*62* 14	30	*93* 25	*12* 16	16	14	9	48	20	7	*38*						
1944	*25* 5		3	3	3	*8*	*18* 4	2	1		5	5	6	*2* 8	20	27	17	6	2	13						

20. AEDES (STEGOMYIA) AEGYPTI (Linnaeus)

Adults and larvae of this species, which is the chief vector of yellow fever and dengue, were collected on several occasions near Camp Shelby from the middle of June until late October. Although found once or twice on the military reservation itself, most collections were in the vicinity of nearby villages, where old tires, bottles, tin cans, etc., provided suitable breeding places.

21. AEDES (AEDIMORPHUS) VEXANS (Meigen)

This was one of the commonest and most pestiferous mosquitoes in the Camp Shelby region. Adults appeared in light-trap catches in March or April and did not disappear until November or December. Several were reared from pupae collected February 10-15, 1944, after a warm period, indicating that a few may reach the adult state at any time during the winter when weather is good. Cool nights may prevent such specimens from being trapped. It is interesting that these pupae were found in almost permanent ponds full of decaying leaves in the Leaf River flats. There they were in company with *Culex apicalis* and *Anopheles punctipennis*. A few larvae at the same time were found in more typical places for the species, as described below.

Larvae of *vexans* usually live in temporary rain pools, often in company with *Psorophora confinnis* during the summer, or in pools left by flooding streams, in foxholes, and in similar collections of water. Rarely they occur in tin cans containing rain water.

In the spring (first half of March) of 1944, numerous larvae were found in floodwater pools of the Leaf River in company with larvae of *Aëdes sticticus, Anopheles punctipennis, Culex apicalis, Psorophora ferox,* and *Psorophora varipes*. Elsewhere at the same season larvae of this species were associated with *Aëdes canadensis*. Repeated floods of the river later in the spring were each followed by a brood of *vexans*.

The accompanying table shows the fluctuations in collections of this species. Each storm during the summer produces numerous situations in which thousands of larvae can grow and result in peak catches.

22. AEDES (AEDES) CINEREUS FUSCUS Osten Sacken

A few adult females thought to belong to this species were collected in the Leaf River bottoms region in June, 1943. However, they were identified merely as "*Aëdes* sp?" at the Fourth Service Command Laboratory at Fort McPherson, Georgia.

On April 7, 1944, however, several larvae of *cinereus* were collected in puddles left by the receding flood waters of the Leaf River. Again on May 24, 1944, two larvae of this species were found in the same area.

Although adults were first collected in light-traps in late May and early June, pupae were found as early as April 5, 1944, and adults emerged immediately thereafter. The lag in spring adult trap catches is probably due to cool evenings which are not favorable for light-trap collections of this species.

TABLE 12.—Specimens of *Psorophora confinnis* by weeks. Larval collections are shown in italics. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.				Feb.				Mar.					Apr.				May					Jun.			
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																							*2*			*17*
																						2	2	39	25	44
1943															*50*	*11*	*17*				*30*		*65*	*32*	*25*	*13*
																					2		2	6	30	10
1944														*5*			*4*				*22*			*32*		
																		3				10	5		30	6

	Jul.				Aug.				Sep.					Oct.				Nov.							Dec.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942	*3*	*35*		*36*	*24*	*25*	*119*	*51*	*59*	*34*	*49*	*34*	*4*													
	57	71	111	92	110	79	54	150	96	75	38	66	40	10	6	3										
1943	*8*	*30*			*31*	*34*			*2*	*37*	*2*	*32*	*12*													
	51	61	52	56	26	45	52	31	7	41	96	3	11	7	3	2	1	1								
1944	*19*	*2*				*65*	*26*	*40*	*17*		*3*			*42*													
	3	56	80	22	42	22	21	13	81	25	36	19	16	13	8	2										

This is primarily a northern species which has not been recorded from Mississippi except from Camp Shelby. The record of a single larva collected at Jackson, Mississippi, in the flood waters of the Pearl River, is therefore of interest.

23. PSOROPHORA (GRABHAMIA) CONFINNIS (Lynch-Arribálzaga)

This was a common and pestiferous species in the warmer months of the year. Biting takes place mostly in the evening. This is not a daytime woodland biter as are the species of the subgenus *Janthinosoma*. The adults were attracted in great numbers to lights, but were only very rarely found resting during the daytime in culverts and similar resting stations.

Larvae were found in temporary rainwater puddles. They develop very rapidly especially in puddles which are exposed to the sun and become hot. The larvae hatch from eggs which survive drying, almost as soon as water fills the puddles. It is interesting to note that both in 1942 and 1943 the peaks of the curve of larval collections coincided with peaks of rainfall.

24. PSOROPHORA (GRABHAMIA) DISCOLOR (Coquillett)

Adults were collected chiefly in light-traps. The larvae occurred in temporary rain pools, often in ones containing some green grass. They were sometimes abundant and were found with *Psorophora confinnis* or *Culex pilosus*. Like *Culex pilosus*, the larvae of this species have a habit of wriggling upside down on the bottom of the puddle or of a container in which they are kept.

Table 13 shows the collections of this species.

25. PSOROPHORA (JANTHINOSOMA) FEROX (Humboldt)

This woodland species was rarely collected even a few yards from the shaded area in which it was sometimes extremely common. The females were severe biters in the daytime. The males were rarely seen except when reared. Adults were only occasionally collected in light-traps.

Larvae were generally in shaded woodland puddles. These puddles were not quite so temporary in nature as those in which *Psorophora confinnis, discolor, ciliata,* and *howardii* occurred. In spring the larvae were found in great numbers in such puddles left by the overflow of the Leaf River. It was then that the large broods of this species emerged. Following a flood in the last of February, 1944, many larvae of *ferox* developed in these puddles. Many had reached the adult stage by March 8 and by March 14 only adults and a few pupae could be found. Most of the adults seen were biting, except for a few of both sexes observed about the edges of the puddles. The Leaf River was again in flood at the end of March and on April 6, many *ferox* larvae were present in pools left by the river.

Summer and fall larvae of this species, as well as some of those found in spring, occurred in shaded rainwater puddles, mostly in or near the area in which spring floods occurred. On one occasion, April 6, 1944, larvae were

TABLE 13.—Specimens of *Psorophora discolor* by weeks. Larval collections are shown in italics. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.					Apr.				May					Jun.		
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																					*2*		*7*		*1*	
																					52	23	7	21	23	17
1943																	*19*				*5*				*2*	
																	1	2			3				4	
1944														*4*								*1*		*2*		
																					2					

	Jul.					Aug.				Sep.					Oct.				Nov.					Dec.			
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942			*1*						*2*	*7*		*7*	*3*													
	16	13		2	10	21	17	24	61	52	19	6				2										
1943										*10*			*14*													
						1		3	1	2	11	4			3											
1944																										
								1		1	2	1	1													

TABLE 14.—Specimens of *Psorophora ferox* by weeks. Larval collections are shown in italics. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.				Apr.					May					Jun.				
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																					*2*				*3*	
																						20	*1*	*5*	*7*	
1943													*2*	*8*	*5*		*7*		*6*	*7*	*11*					*12*
																				1			1	6	3	2
1944									*8*	*40*			*4*	*50*			*1*	*9*			*9*					
											2	2					1						2			

	Jul.					Aug.			Sep.				Oct.				Nov.					Dec.				
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942				*1*				*11*					*15*													
	7		1			1											1									
1943					*10*	*34*					*1*	*6*														
	2	2					2	3	1	2		3		1	1											
1944	8	*1*								*7*				*4*												
							1		2		1															

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TABLE 15.—Specimens of *Psorophora varipes* by weeks. Larval collections are shown in italics. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.					Mar.					Apr.					May					Jun.				
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26			
1942																					2	1	2	2	2	1			
1943																							16	39	41	43			
1944										*5*	2		*17*	*27* 1	1	4	8					*1* 16	1		1			

	Jul.					Aug.					Sep.					Oct.					Nov.					Dec.				
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52			
1942	7										2																		
1943	12																												
1944																													

found in water in contact with the soil but inside a hollow stump in which *Culiseta melanura* was also found. This was a very unusual association.

Contrary to certain descriptions, both upper and lower head hairs of larvae of this species may be trifid, although at least the upper ones are often double. There may be from two to five pecten teeth. Several adult specimens of this species have been seen with the third hind tarsal segment completely dark, thus agreeing with *Psorophora longipalpis* and *horrida* from which they differ by the mesonotal vestiture.

Table 14 shows the collecting records of this species at Camp Shelby. To a large extent it fails to show the huge spring broods because the adults rarely leave the periodically flooded woods in which they breed and larval collections were not always frequent enough in these areas.

26. PSOROPHORA (JANTHINOSOMA) HORRIDA (Dyar and Knab)

Forty-four females of this species were collected from June 6 to June 23, 1942. A few larvae were found in a pool in the wooded floodlands along the Leaf River in May, 1943. In June 1944, many adults were found in this same area from early April to early June. A few males were swept from the vegetation, but females were present in immense numbers and were severe biters. The biting and flight habits of the adults seem to be very similar to those of *ferox*. *Psorophora horrida*, however, at least in 1944, became abundant just as *ferox* was becoming scarce. There was no evidence of summer and fall breeding of *horrida* such as occurs with *ferox* and *varipes*, although Roth (1945) records an August brood.

27. PSOROPHORA (JANTHINOSOMA) VARIPES (Coquillett)

The habits of this species appear to be similar to those of *ferox*. Males and larvae were not taken in or near Camp Shelby during 1942 or 1943, although females appeared once, June, 1943, in almost unbearable swarms in the wooded swamps along the Leaf River.

In early *March*, 1944, however, larvae were found in small numbers with those of *ferox* in woodland puddles left as the river receded. Adults were reared from these immature stages as early as March 8, 1944, and by March 14, only adult females could be found. Although larvae of this species were far less common than those of *ferox*, the females bit more severely. Perhaps they are more strongly attracted to man than is *ferox*. As with *ferox* another large brood of this species followed the next flood of the Leaf River at the end of March, and a few specimens were collected much later in the year.

Larvae of this species may be distinguished at sight from those of *ferox* by the smaller size, darker coloration, and usually by the pale subapical ring of the air tube. They are, however, more similar to those of *ferox* than descriptions indicate. It is just possible that two species are confused under the name *varipes*.

TABLE 16.—Specimens of *Culiseta inornata* by weeks. Larval collections are shown in italics. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.					Apr.			May					Jun.		
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942										*1*																
1943	*75*	*36*	*34*	*3*	*14*	*11*	*25*	*10*	*5*	*2*	*12*	*2*	*2*	*4*												
	34	96	39	111	220	227	148	243	67	163	4	16	3	6												1
1944				*1*			*2*	*3*	*6*	*9*					*3*											
	1		2	2	1	19	7	4	17	5	4	2		1												

	Jul.					Aug.				Sep.					Oct.			Nov.					Dec.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942																						*10*		*35*	*22*	*30*
										1								116	376	30	242	554	189	169	188	276
1943																										*5*
																	15	20	36	4	8	19	16	9	2	3
1944																										
															1	5	5		4	24	54					

The following characters distinguish Camp Shelby specimens of *varipes* not only from *ferox* but from certain previous descriptions of *varipes* larvae: both upper and lower head hairs two- to four-branched, usually three-branched; lateral hairs of third abdominal segment four- or five-branched, of fourth double or rarely single, of fifth single or rarely double, and of sixth and seventh single (this as in *ferox* but differing from descriptions of *varipes*); comb scales six or seven in number, only three median ones arising from a darkened area (four or usually five arising from darkened area in *ferox*); lateral teeth of comb scales short and inconspicuous (one or more teeth of each scale at least one-third as long as median spine in *ferox*); pecten consisting of three or four spines on each side of air tube, each spine with a small tooth on each side at base (in *ferox* tooth on one side of spines much larger than on other, except for basal pair of spines); air tube less inflated, especially apically, than in *ferox*.

Table 15 shows the collecting records of this species at Camp Shelby.

28. PSOROPHORA (JANTHINOSOMA) CYANESCENS (Coquillett)

A single specimen of this species was collected while biting in the shade in the Leaf River swamp on April 15, 1944.

29. PSOROPHORA (PSOROPHORA) CILIATA (Fabricius)

This and the next species were captured occasionally at Camp Shelby during the summer. Some adults were collected biting during the daytime and others were caught in light-traps. The larvae of both species are predaceous on other aquatic organisms, chiefly larvae of *confinnis* with which they are ordinarily associated in temporary rain puddles and temporary water in artificial pits. Occasionally they were found in company with *ferox* upon which they presumably feed.

A total of thirty-two larvae (ten collections) and fourteen adults (twelve collections) were obtained at Camp Shelby. These collections were scattered erratically, those of the larvae ranging from April 15 to October 25, those of the adults, from April 1 to October 7.

30. PSOROPHORA (PSOROPHORA) HOWARDII Coquillett

A total of thirty-nine larvae (twelve collections) and nine adults (nine collections) were obtained at Camp Shelby. Collecting dates are scattered erratically, those of larvae from April 10 to September 16, those of adults from April 28 to September 8.

For additional notes on this species see *ciliata*.

31. CULISETA (CULISETA) INORNATA (Williston)

This species was found at Camp Shelby chiefly during the winter months, when the adults were attracted to light-traps in large numbers. The larvae did not appear to be correspondingly abundant. How the species passes the summer is not clear, unless the adult females aestivate. A single female specimen was collected in a light-trap in September, 1942, and another in June, 1943. These are the only records for the warmer months.

TABLE 17.—Specimens of *Culiseta melanura* by weeks. Larval collections are shown in italics. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.				Feb.			Mar.						Apr.				May						Jun.		
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																					*30*	*15* 1	*2*	*3* 6	*1* 1	4
1943		*6*	*10*					1					*1* 2					5	*2* 1	*4*	*19*	*4* 3	*11*	*9*	*3*	
1944				*3*	*4*	*24*		*14*	*9*						*3*	*3*				*4*	2	*2*	*6*	*2*	*23*	2

	Jul.				Aug.			Sep.						Oct.				Nov.						Dec.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942	*1* 3				*23*	*2*															3	7				2
1943			*4*	*16*		*1*		3						*5* 1				9	1	*2* 1			*3* 1			*4*
1944	5	*2*	*6*	*6* 2	*3*			2		2	*3* 1	1	3	3	5	*3* 17	25	4	3	4						

Such larvae as were found were collected weeks or months after the first appearance of adults in the autumn. All autumn adults collected were females. The few larvae found in December, 1943, were in tin cans and barrels and were collected dead a day or two after a hard freeze. Larvae were usually found in pools and ponds, however, often associated with those of *Culex apicalis* and *Anopheles punctipennis*.

32. CULISETA (CLIMACURA) MELANURA (Coquillett)

The adults were almost all taken in light-traps. Larvae were ordinarily found in small, thoroughly shaded, more or less permanent collections of water. Some examples of typical larval collecting places are small, grassy ponds of dark, acid water in a wooded swamp, water-filled hollows under the roots of trees, and water in hollow stumps in which the water is in contact with the soil beneath the stumps. On one occasion several larvae were taken in water in a shaded barrel in association with *Aëdes triseriatus*. Otherwise this species was not found with true tree-hole mosquitoes.

33. ORTHOPODOMYIA SIGNIFERA (Coquillett)

Very few adults of this species were collected in the usual ways at Camp Shelby since they do not bite man and are only very rarely found in light-traps or resting stations. Occasionally one was found resting by day on the inside of a cavity in which larvae occurred, but adults were obtained in numbers only by rearing the slow-growing larvae. Adult collections ranged from the fourteenth to the forty-second weeks of the year.

Larvae were found chiefly in tree-holes, where they were commonly associated with *Aëdes triseriatus*. Less frequently they occurred in tin cans, barrels, etc., if in the shade and containing some decaying leaves. Rarely in such situations they occurred with *Culex quinquefasciatus*.

34. ORTHOPODOMYIA ALBA Baker

A single larva of this species was collected in a tin can on August 10, 1943. It was not studied by the author but was identified by Maj. W. W. Middlekauff and the identification verified by Dr. Alan Stone. Numerous larvae of *signifera* have been examined and no additional specimens of *alba* obtained. It is noteworthy that third instar larvae of *signifera* have many of the characteristics of *alba* and may easily be identified as that species unless recognized as immature.

35. MANSONIA (COQUILLETTIDIA) PERTURBANS (Walker)

Adults of this species were collected occasionally, both in light-traps and when biting, from early May to late September. With the exception of the twenty-third week of 1942, when seven specimens were collected, only a single one was taken in any one week.

No larvae were found at Camp Shelby.

TABLE 18.—Specimens of *Orthopodomyia signifera* larvae by weeks. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.			Mar.				Oct.					Nov.						Dec.		
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																					*17*	*33*	*14*	*14*	*15*	*13*
1943	*33*	*19*											*2*	*1*						*5*	*2*	*3*		*14*	*2*	*11*
1944	*19*		*7*	*4*			*17*		*23*	*16*			*61*	*16*	*15*			*33*	*12*	*6*	*3*	*7*	*10*	*9*	*3*	*13*

	Jul.				Aug.				Sep.				Apr.					May						Jun.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942	*2*	*1*	*4*			*29*		*4*	*16*	*25*	*10*	*5*	*4*	*7*	*5*	*10*		*6*	*2*	*4*		*6*	*5*	*9*	*12*	*14*
1943	*7*	*14*	*16*		*11*	*16*	*5*		*3*	*15*		*13*	*3*													
1944	*21*	*35*	*11*	*8*	*13*	*1*	*4*	*13*	*6*	*7*		*3*	*2*		*15*											

36. URANOTAENIA SAPPHIRINA (Osten Sacken)

Practically all adults of this species, except as indicated below, were taken in light-traps. A very few were collected in privies, culverts, and similar resting stations although about forty were found in a single hollow stump in October, 1943. This species was not observed biting man.

This species passes the winter as adult females in large hollow trees such as those in which *Anopheles quadrimaculatus* is found, and was collected by the method described for that species. The many specimens obtained in this way are not indicated on the accompanying table. Warm winter days did not seem to be sufficient to cause specimens of this species to emerge from their resting places.

The larvae of *sapphirina* were not collected in large numbers at Camp Shelby but were taken from early April to the end of September, with collections small, irregular, and showing no peaks such as are evident with the adults. Such late summer and autumn peaks were evident, however, in larval collections made at an artificial lake about two miles from Camp Shelby. Here there was a much larger suitable breeding area than at Camp Shelby. Larvae occur in clear sunlit pools or lakes containing much emergent vegetation. They are often collected with *Anopheles quadrimaculatus*.

37. URANOTAENIA LOWII Theobald

Although this tiny species was formerly thought to be rare, it was commonly collected in light-traps at Camp Shelby. Indeed, in 1942, it was collected in larger numbers during one week than was *sapphirina* during any week of the year. Its season of flight, however, extending from June to November, appears to be shorter than that of *sapphirina*. It is interesting to note that both in 1942 and 1943 this species reached its maximum abundance, as judged by light-trap catches, two weeks before *sapphirina* did so. No specimens of *lowii* were collected biting or in resting stations. A few were swept from shaded herbaceous vegetation during the daytime.

Larvae were collected during the twenty-ninth and thirty-seventh weeks of 1943 only. They were found in small pools similar to those in which the preceding species occurs. The scarcity of larvae suggests that adults may fly for considerable distances.

38. CULEX (CULEX) QUINQUEFASCIATUS Say

Adults were caught in some numbers in light-traps and, unlike *restuans*, were found during the daytime in culverts, privies, and similar resting stations with species of *Anopheles*. The females bite freely during the twilight and dark hours and regularly enter buildings to bite.

Larvae of this species were collected in artificial containers of water such as tin cans and barrels, as well as in pools of polluted water and along the edges of polluted streams. It is interesting to note that the three highest peaks in larval collections of this species for 1943 coincided with the ends of three-week periods during which the weekly rainfall was at least .7 of an inch. This is

TABLE 19.—Specimens of *Uranotaenia sapphirina* adults by weeks. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.					Apr.				May					Jun.		
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																								14	34	16
1943										1			4			1	2									
1944											5	2								1				1	4	

	Jul.					Aug.				Sep.					Oct.				Nov.					Dec.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942	2	23	3	6	16	46	16	13					41	132	108	28	8	34	2				1			
1943			2			1	12	15	13	29	4	282	145	50	20	20	24	4								
1944				2		2		2	2	3	19	3	6	2	62	20	14	5	2							

TABLE 20.—Specimens of *Uranotaenia lowii* adults by weeks. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week. The first half of the year is omitted from this table as no specimens were collected during that period.

	Jul.				Aug.				Sep.					Oct.				Nov.						Dec.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942		7				5	9		11	86	80	194	121	65	18	15	2	8								
1943		1			4			13	19	52	6	9	2	2		2	2									
1944			2		1		4	46	15	2	5	41	1	18	5											

TABLE 21.—Specimens of *Culex quinquefasciatus* by weeks. Larval collections are shown in italics. No records are available for 1944 after the forty-seventh week. Records for 1942 are omitted.

	Jan.				Feb.				Mar.					Apr.				May					Jun.		
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1943	*10*	*5*													*16*			*16*	*14*	*18*	*7*	*30*	*22*	*26*	*49*	*80*
																			2			6	27	28	20	28
1944	*2*	*3*	*5*	*8*	*3*	*1*											*24*			*4*	*9*	*11*	*22*	*2*	*11*	*35*
												2			1		1				8	1	3	12	35	9

	Jul.				Aug.				Sep.					Oct.				Nov.					Dec.			
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1943	*70*		*10*	*29*	*23*	*135*	*25*	*60*	*62*	*34*	*69*	*119*	*37*	*13*	*3*	*24*		*8*		*2*			*5*		*2*	
	15	13	3	257	58	32	47	11	24	36	37	49	97	143	43	37	13	12	8	5	2	25	44	1	1	
1944	*73*	*59*	*43*	*6*	*25*	*12*	*12*	*34*	*41*	*23*	*13*	*18*	*4*	*54*	*8*	*3*	*12*	*9*	*31*	*8*						
	17	11	2	257	59	35	11	47	35	12	24	6	5	28	9	59	34	28	18	50	3					

TABLE 22.—Specimens of *Culex restuans* by weeks. Larval collections are shown in italics. No records are available for 1944 after the forty-seventh week. Records for 1942 are omitted.

	Jan.					Feb.					Mar.					Apr.					May					Jun.				
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26				
1943	*254*	*181*	*61*	*115*	*103*	*50*	*94*	*102*	*60*	*63*	*35*	*98*	*108*	*187*	*342*	*328*	*123*	*345*	*140*	*54*	*58*	*28*	*12*	*23*	*4*	*40*				
	11		2	3	5	1								9	1	5	9	3	3	21			14		16	9				
1944	*105*	*73*	*182*	*135*	*120*	*265*	*415*	*320*	*250*	*258*	*398*	*270*	*158*	*375*	*215*	*261*	*250*	*104*	*78*	*71*	*82*	*27*	*48*	*20*	*15*	*2*				
	2			13	7	12	4	10	10	20	84	19	5	14	9	8	11	5	2	21		5	3	3	2	1				

	Jul.					Aug.					Sep.					Oct.					Nov.					Dec.				
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52				
1943	*14*	*3*	*9*	*29*			*6*	*6*	*6*		*8*	*6*	*200*	*84*	*8*	*54*	*222*	*63*	*18*	*33*	*108*	*121*	*95*							
	7	1	5	1							1		1	40	240	100	206	130	10	40	11	52	53	14	1	3				
1944	*1*	*44*						*2*			*16*		*9*	*2*	*2*	*33*	*3*	*4*	*44*	*19*	*24*									
											2		1	1	50	210	149	102	36	50	5									

probably because numerous artificial receptacles were kept filled by such rainfall. Of course heavy rains flush out streams polluted by septic tanks and the like and thus reduce the population, but polluted water was not the chief source of this mosquito at Camp Shelby. Numerous larvae of this species were once found in water in unused toilet bowls, frequently associated with larvae of *Psychoda* sp?

In the accompanying table no records are given for 1942 because the identifications indicate considerable confusion with *restuans*.

39. CULEX (CULEX) RESTUANS Theobald

Adults were collected in large numbers in light-traps, particularly in the fall. Although larvae were very abundant in the spring, adults were not captured in large numbers at that season. The adults apparently spend the day in damp vegetation and in small shaded spots rather than in large culverts and similar resting places such as are attractive to *Anopheles* and *Culex quiquefasciatus*. Females of *restuans*, even when abundant, were rarely seen biting.

Adults of this species were often seen in flight during the twilight hours. About half an hour after sundown on the evening of October 28, 1943, a large dancing swarm of males was observed. About 200 were organized into a swarm about two feet in diameter and four to six feet in height. The individual mosquitoes flew up and down, but the swarm as a whole remained in about the same position, its lowest part about five feet above the ground and about two feet above the top of a bush. This performance continued at least until it became too dark to see it. Occasionally a breath of air would carry the swarm a few feet from its usual position, but it quickly returned. A search of the surrounding area showed no similar swarms. A few females were seen flying more or less horizontally, but none were seen to pass through the swarm or to mate.

Adults developing from larvae growing in acid water full of decaying vegetation were generally smaller and darker than those from other water, and less than 50 per cent of the specimens from such sources had the usual pair of pale mesonotal dots.

Larvae were observed in a wide variety of pools and streams. Usually they were not found in highly polluted water, but they did appear in immense numbers in pools and quiet eddies of a stream carrying laundry waste water. They were also found occasionally in artificial containers such as tin cans and barrels. Heavy storms destroyed great numbers by flushing them out of pools along streams but at the same time filled pits, artificial containers, and woodland puddles in which many more could live. Weekly collections of this species are shown in table 22.

40. CULEX (CULEX) SALINARIUS Coquillett

This was a moderately abundant species at Camp Shelby. Most of the adults collected came from light-traps, although several were taken while biting. Larvae were taken in more or less permanent pools containing considerable clear water.

TABLE 23.—Specimens of *Culex salinarius* by weeks. Larval collections are shown in italics. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.				Feb.				Mar.						Apr.				May						Jun.			
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		
1942																					*2*		*12*	*25*				
																					31	16	24	45	39	48		
1943					*1*											*6*	*20*	*71*	*25*	*18*	*3*	*2*	*6*	*9*	*5*	*9*		
					6	20		3	4						2	7	20	6	18	30	26	9	20	26	7	4		
1944																*1*			*8*		*5*	*8*				*6*		
									1		1	2	2	2	9	22	12	16	3	5	11	9	62	6	7			

	Jul.				Aug.				Sep.					Oct.				Nov.					Dec.					
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52		
1942			*1*																	*1*		*6*		*2*	*3*			
	31	20	15	9	4	2			1	12	11	24	36	9	20	10	3	5		10					1			
1943												*2*	*2*			*3*	*4*											
	4	7						10		3		2	29	13	24	45	20	11	10			3	2					
1944		*5*		*2*									*8*															
	3	3	3	4	3			2			13	4	21	2	96	14	8	4	8	13	5							

TABLE 24.—Specimens of *Culex nigripalpus* by weeks. Larval collections are shown in italics. No records are available for 1944 after the forty-seventh week. The first half of the year is omitted from this table as no specimens were collected during that period.

	Jul.				Aug.				Sep.					Oct.				Nov.					Dec.					
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52		
1942																												
1943							*2*			*4*	*30*																	
																		3										
1944							*1*	*5*			*1*	*2*			*2*													
								1		1			1		4													

Although specimens of this species apparently can be found in any season of the year at Camp Shelby, they were scarce in winter and in midsummer. Each year curves for catches of this species are clearly bimodal, with high catches for adults in May and June and again in September and October. See table 23.

41. CULEX (CULEX) NIGRIPALPUS Theobald

This species was not collected at Camp Shelby except for short periods in the fall of 1943 and 1944 when larvae were found on a number of occasions in water in artificial pits, pools, etc. Adults were collected in light-traps. Table 24 shows the collecting records for this species.

42. CULEX (CULEX) TARSALIS Coquillett

This species was not found at Camp Shelby in 1942, but both larvae and adults were collected in the fall of 1943 and adults again in the same season of 1944. All adults were taken in light-traps. In 1943 eight adult specimens were collected on scattered dates from late September to late November, and larvae were obtained in the first week in October. In 1944 three adults were collected in the first two weeks of October.

It is interesting that this western species apparently suddenly became distributed in the southeast. Until 1942 it had not been found in the southeastern region except in Louisiana, Arkansas, and Virginia. In 1942 it was recorded from Tennessee, but was not found in other southeastern states in spite of intensive collecting (see King, Roth, Toffaleti, and Middlekauff, 1943). In 1943, however, as recorded by Middlekauff and Carpenter (1944), it was found in Tennessee, Mississippi, Alabama, Georgia, Florida, and South Carolina.

43. CULEX (NEOCULEX) APICALIS Adams

Adults and larvae of this species were found throughout the year at Camp Shelby. Although the adults were not commonly taken, since they do not bite man, are not attracted to light, and only rarely are taken in the resting stations, larvae were usually common. Adults were obtained in moderate numbers by sweeping vegetation and by collecting them from pits in the soil, shaded earth banks, etc. Adults were especially abundant at times resting on the shaded sides of pits above water in which larvae were present.

The larvae were found in artificial pits, in puddles of quiet water along streams, in pools of seepage water partially filled with decaying leaves, and less commonly in ponds and lakes such as those in which *Anopheles quadrimaculatus* is found. They were collected in both sunlit and shaded water. On February 11, 1944, about twenty larvae of this species ("summer form") were found in water in a shaded tin can in company with *Aëdes triseriatus*. This is a very unusual association.

Larvae occurring during the winter months are larger with shorter and more robust air tubes than most of those found during the summer. Winter adults are generally larger, with darker ground color but broader white abdominal

TABLE 25.—Specimens of *Culex apicalis* larvae by weeks. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.				Mar.					Apr.				May					Jun.			
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																					*34*	*51*	*28*	*50*	*10*	*61*
1943	*94*	*43*	*34*	*12*	*8*	*4*	*10*	*45*	*14*	*18*	*58*	*70*	*107*	*37*	*37*	*14*	*183*	*40*	*37*	*24*	*38*	*43*	*5*	*20*	*3*	*40*
1944	*3*	*12*	*36*	*45*	*45*	*33*	*88*	*161*	*87*	*200*	*164*	*232*	*50*	*70*	*65*	*24*	*58*	*16*	*56*	*21*	*8*	*38*	*60*	*30*	*10*	*18*

	Jul.					Aug.			Sep.					Oct.					Nov.					Dec.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942	*9*	*60*	*19*	*34*	*40*	*22*	*41*	*11*	*4*	*48*	*21*	*3*	*7*	*25*	*28*	*30*	*6*	*10*	*10*	*23*	*26*	*28*	*38*	*43*	*30*	*41*
1943	*28*	*18*	*16*	*13*	*17*	*31*	*100*	*30*	*8*	*6*	*32*	*25*	*33*	*10*	*80*	*34*	*76*	*85*	*15*	*38*	*17*	*2*	*14*		*58*	*70*
1944	*35*	*22*	*9*	*19*	*4*			*30*	*21*	*7*	*11*		*4*	*16*	*11*	*18*	*12*	*2*	*6*	*13*	*1*					

bands than the summer form. This phenomenon is more fully discussed elsewhere (Michener, 1945).

44. CULEX (MELANOCONION) ERRATICUS Dyar and Knab

The females of this and the next two species are very similar and have not been differentiated in the Camp Shelby records. The information here provided is, therefore, based upon larvae and males only.

The adults of this species were collected in small or moderate numbers in culverts and similar daytime resting stations. They were also taken in light-traps.

During the winter numerous females, no doubt of this species, were obtained from hollow trees by spraying with fly spray as in the case of *Anopheles quadrimaculatus* and *punctipennis* and *Uranotaenia sapphirina*. Like *Anopheles punctipennis* they apparently fly some during warm periods in winter and at such times a few were collected in culvert resting stations. On February 21, 1944, several females in such a resting station bit when the culvert was entered. In spite of the great abundance of larvae during the summer of 1944 in a lake about two miles from Camp Shelby, adult *erraticus* were never troublesome biters there. They were observed, however, concentrated around chickens in a nearby henhouse.

Larvae were usually found in situations such as those in which *Anopheles quadrimaculatus* is found. It was noted, however, that unlike the *Anopheles*, *erraticus* often occurred where water scum was present.

Table 26 shows the weekly catches of this species based on larvae and males.

The females of *Melanoconion* collected at Camp Shelby were undoubtedly mostly *erracticus*. The records for females add little to the picture indicated in Table 26 except that the females were more frequently collected and there were several collections of females between the fortieth and forty-eighth weeks.

45. CULEX (MELANOCONION) PECCATOR Dyar and Knab

This species was not recognized in 1942, but a few males were found in light-traps during the summer and autumn of 1943 and 1944. In 1943, but three specimens were taken, one in the last week in August, the others in the first week in September. In 1944, one was taken June 29, and sixteen others scattered from the middle of July to the middle of November.

Two larvae were found on August 7, 1944, in a swamp in company with *Culex erraticus* and another on November 16, 1944, with numerous *Culex apicalis*.

46. CULEX (MOCHLOSTYRAX) PILOSUS (Dyar and Knab)

Males of this species were collected occasionally in light-traps from late August to the middle of October of both 1943 and 1944. Five larvae were taken in a temporary pool on September 28, 1943. Many additional larvae were collected in similar pools about two miles from Camp Shelby on Septem-

TABLE 26.—Specimens of males and larvae of *Culex erraticus* by weeks. Larval collections are shown in italics. No records are available for 1942 prior to the twenty-first week or for 1944 after the forty-seventh week.

	Jan.					Feb.			Mar.					Apr.					May					Jun.		
weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1942																										*30*
1943				*1*					10		*1*	*1*							*1* 6	*1*	 7		*1* 5	 4		*2* 5
1944																										

	Jul.				Aug.				Sep.					Oct.					Nov.					Dec.		
weeks	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1942	*13*	*2*			*8*			*4*						 7												
1943			*9*				*6*		*6* 1		*18*	*2*	*1*									 3				
1944	5	 1	*3* 1		*8* 1		*7* 1		*3*	*14* 2	*12*		*10* 2	 1					 -	 4						

ber 5 and 9, 1943, and a series of adults emerged from these collections within a day or two. In 1944 larvae were collected several times during September and October. The larvae have a wriggling motion similar to that of *Psorophora discolor*, with which they are sometimes associated. They have also been collected with *Psorophora confinnis*.

47. MEGARHINUS (MEGARHINUS) SEPTENTRIONALIS Dyar and Knab

The adults of this species were not collected in resting stations or light-traps, for they appear to be diurnal. Twice females were observed sucking from flowers in the sunlight, and one was once seen flying from tree trunk to tree trunk, frequently alighting in the sun. The larvae were found in tree holes or, less often, in tin cans or barrels containing larvae of *Aëdes triseriatus* or *Orthopodomyia signifera*, upon which *septentrionalis* is predaceous.

On July 6, 1944, eighteen eggs of this species were found floating on the water surface in a small tree hole. Several of them were in a small group while others were single. The eggs are oval, brilliant white, appearing granular, about 0.6 mm. long and 0.3 mm. broad. At one end is a slightly darkened spot. All eggs hatched within a few hours after being brought into the laboratory, suggesting that they may all have been laid at one time by the same female. In hatching the egg shell is split lengthwise into two halves which frequently remain attached to one another by a narrow ribbon of shell. When placed in alcohol the white of the shell immediately disappears, leaving the chorion transparent and slightly brownish. It did not occur to me when these observations were made that the white color of the eggs might be produced by fine bubbles, as is indicated by some authors.

The following data give some indications of the seasonal activities of this species: Eggs were found on July 6, August 21, September 8 and 28, 1944. Larvae can be found at any season. They grow slowly even in summer, at which time larvae of all sizes can be found. Thus a half-grown larva collected on August 22, 1944, did not pupate until September 7, although provided with abundant food. All larvae collected during the winter were full grown. Apparently the species passes the winter as mature larvae. Four such larvae were collected in September, 1943, kept indoors and provided regularly with other mosquito larvae. Two of them pupated on March 12, 1944, and emerged on March 18, while the others pupated on April 6 and emerged April 14. A pupa collected in the field emerged April 20. During June and July the pupal stage was noted to be about a week in length, and a specimen which pupated on September 7 emerged September 12.

Appendix A

The following species have been collected in Mississippi but not at Camp Shelby:

1. *Anopheles* (*Anopheles*) *pseudopunctipennis* Theobald (Recorded from several localities in the central western portion of Mississippi).

2. *Aëdes* (*Ochlerotatus*) *grossbecki* Dyar and Knab (A rare northern species probably not occurring in the southern part of the state).

3. *Aëdes* (*Ochlerotatus*) *tormentor* Dyar and Knab (Apparently to be expected in the Camp Shelby area).

4. *Aëdes* (*Ochlerotatus*) *stimulans* (Walker) (A northern species probably not occurring in the southern part of the state).

5. *Culex* (*Culex*) *pipiens* Linnaeus (Recently recorded from northern Mississippi by Wanamaker, Chamberlain, and Carpenter, 1944; not expected in the southern part of the state).

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AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK, N. Y.

Parasites Found in Certain Oregon Bats With the Description of a new Cestode, Hymenolepis gertschi

Ralph W. Macy

During the period between August 13 and 24, 1938, the writer collected fourteen *Myotis californicus caurinus* Miller and four *Myotis evotis evotis* (A. Allen) at Nelscott, Oregon, and a single *Myotis californicus caurinus* near McMinnville, Oregon. Nelscott is a seashore resort and the bats obtained there were taken from their daytime hiding places in the coniferous forest about one mile from the village. Small streams and a nearby freshwater lake might serve for the development of probable arthropod intermediate hosts of the trematodes found.

Thanks are due to Dr. Stanley G. Jewett, U. S. Biological Survey, Portland, Oregon, for suggestions which aided in the collection of the hosts. Gratitude is also expressed to Dr. Glen M. Kohls, Rocky Mountain Laboratory, U. S. Public Health Service, Hamilton, Montana, for help in determining the flea reported in this paper.

Trematoda

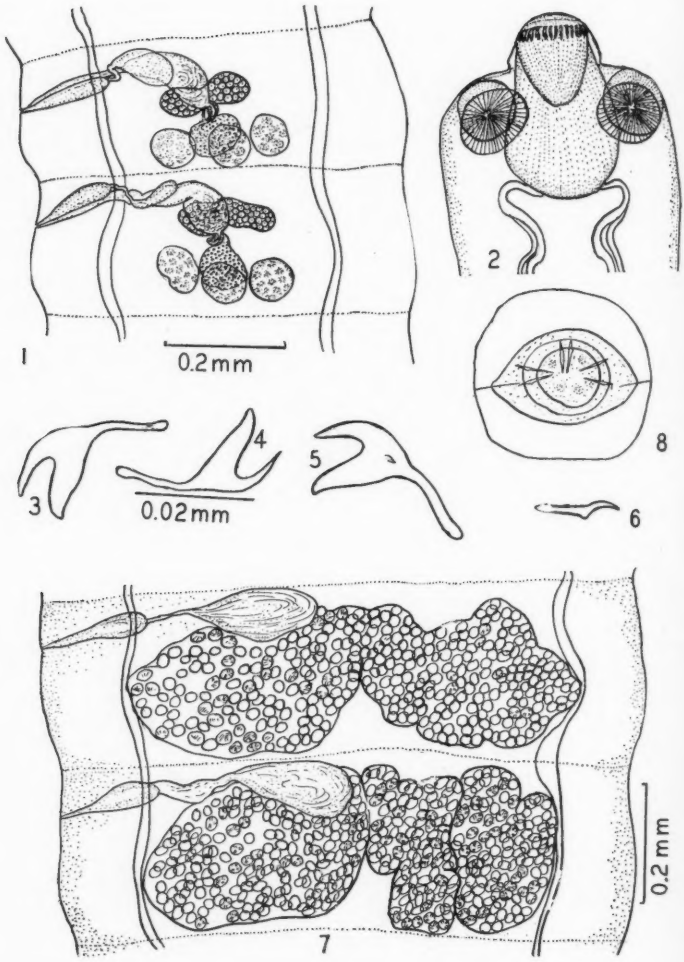
Lecithodendriidae

Limatulum gastroides Macy, 1935. This fluke was found in the stomachs of five *Myotis californicus caurinus* at Nelscott, Oregon. In three hosts there was one each, and in the others, five and six flukes respectively. Measurements correspond closely to those of the type material taken from *Myotis lucifugus* in Wisconsin and Minnesota. These records indicate a wide geographical range for the species.

Acanthatrium oregonense Macy, 1939. A total of 347 of this species was obtained from the intestines of the hosts, of which 169 were in the four *Myotis evotis evotis* and the remainder were in *Myotis californicus caurinus*. This is the first record of the genus west of the Rocky Mountains.

Allasogonoporus vespertilionis Macy, 1940. This trematode was found in the intestine of a single *Myotis californicus caurinus* shot near McMinnville, Oregon, and is very closely related to *A. marginalis* Olivier, 1938, from the intestine of the muskrat in Michigan. It now appears that Olivier's specimens of *A. marginalis* were poorly preserved and therefore a redescription of his species will be necessary before it will be possible to determine the final status of *A. vespertilionis*.

In addition to the trematodes which could be identified, a single immature specimen of a lecithodendriid with lateral genital pore was found in the intestine of *Myotis californicus caurinus* caught near Nelscott.



All figures pertain to *Hymenolepis gertschi*, n. sp., and except fig. 8, were drawn with the aid of a camera lucida. 1. Mature proglottids. 2. Scolex and neck. 3, 4, 5, rostellar hooks. 6. Hook from egg. 7. Ripe proglottids. 8. Living egg.

CESTODA

Hymenolepis gertschi, n. sp.

Specific diagnosis.—Hymenolepis: Maximum length of the strobilus about 55 mm., margins not serrate. Mature proglottids average 0.65 mm. wide by 0.23 mm. long. Genital pores unilateral, without any noted exception, located just anterior to the middle of the proglottid. Scolex about 0.4 mm. wide, only slightly wider than the neck region. Suckers 0.08 to 0.10 mm. in diameter. Rostellar sac 0.18 mm. long by 0.18 mm. wide. Rostellum with a crown of 35 to 41 hooks, each measuring 0.026 to 0.029 mm. in length. Handle of each hook with a slight, characteristic bend as illustrated.

The internal structures were determined from a number of stained whole mounts supplemented with transverse serial sections. The three testes placed very close together in a transverse row near the central, posterior part of the proglottid. Average diameter of each testis 0.075 mm. Internal seminal vesicle 0.096 mm. long by 0.050 mm. wide. Cirrus sac 0.090 to 0.120 mm. long by 0.030 to 0.038 mm. wide. Ovary 0.16 mm. long by 0.05 mm. wide, anterior to the testes and on the longitudinal axis of the proglottid. Vitelline mass about 0.07 mm. in diameter, overlapping the central testis. Seminal receptacle 0.130 mm. long by 0.062 mm. wide. Eggs 0.027 mm. my 0.032 mm. in size. Hooklets of the hexacanth embryo about 0.014 mm. in length. Living eggs have fine polar filaments as illustrated, but these are not easily detected in preserved material.

Host: Northwest Coast Bat (*Myotis californicus caurinus* Miller).

Habitat: Intestine.

Locality: Nelscott (Lincoln County), Oregon.

Type specimen: U. S. Nat. Mus. Helm. Col:; paratypes in author's collection.

In comparing *Hymenolepis gertschi* with other bat cestodes of the same genus it is seen to differ from *H. sandgroundi* Baer, *H. kervoulae* Hubscher, *H. balsaci* Joyeux and Baer, and *H. chiropterophila* Vigueras in the possession of more numerous hooks. Measurements recently made from abundant material of *H. christensoni* Macy indicate that the length of the hooks is usually near 38μ, with a range of 33μ to 38μ, whereas in the new species the hooks are definitely smaller. *Hymenolepis acuta* (Rudolphi) also has larger hooks than *H. gertschi*. The latter differs from *H. decipiens* in that the new species has larger hooks and a relatively shorter cirrus pouch which is about one-fifth of the body width.

ARTHROPODA

From the fur and wing membranes of *Myotis californicus caurinus* were taken five fleas, *Myodopsylla gentilis* Jordan and Rothschild, and numerous mites. No external parasites were found on *Myotis evotis evotis*.

Summary

An investigation of the parasites of a limited number of Oregon bats of the genus *Myotis* yielded the following identified parasites:

Myotis californicus caurinus collected at Nelscott (Lincoln County) Oregon: *Trematoda: Limatulum gastroides; Acanthatrium oregonense. Cestoda: Hymenolepis gertschi,* n. sp. *Insecta: Myodopsylla gentilis.*

Myotis californicus caurinus collected at McMinnville (Yamhill County) Oregon: *Trematoda: Allasogonoporus vespertilionis.*

Myotis evotis evotis collected at Nelscott: *Trematoda: Acanthatrium oregonense.*

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Growth and Environmental Conditions in Southern California Chaparral

Erwin H. Miller, Jr.

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Introduction

Chaparral, the natural foothill vegetation of southern California, is typically a scrub of varying density, composed chiefly of broad-sclerophyll shrubs. It is characterized by an actual or apparent evenness in height, and by a density usually so great that annuals appear only along roads and trails (Brandegee, 1891). Its development is a response partly to climatic and soil conditions, and partly to fires which have swept it at intervals for centuries (Jepson, 1925).

This investigation was conducted to determine the effect of certain environmental conditions on the growth of some of the more common species in chaparral and two related communities, coastal sage, and broad-sclerophyll woodland, in the San Gabriel Mountains of southern California. To determine the effect of altitude and slope exposure, ten stations were established in pairs on opposite north and south slopes at intervals of about 1000 feet, from approximately 1500 to 5500 feet elevation. Instrumental work was begun in December, 1935, and soil moisture sampling in May, 1936, both being terminated at the end of the growing season in August, 1938. Readings were made at two-week intervals for the most part.

In this paper, air temperature, evaporation rates, soil temperature and soil moisture are analyzed with special reference to the effect of altitude and slope exposure, and the effect of these conditions upon the type of vegetation; the growth of the more common species is noted.

Review of Literature

Though descriptions of the chaparral had been written by taxonomists, phytogeographers, and foresters, the first monograph describing ecological relations in chaparral supported by instrumental data was published by Cooper in 1922. Instrumental work was carried on for more than a year near Palo Alto, California, with other studies occupying portions of several years. In 1927, Shreve described the vegetation and physical conditions of the Santa Lucia Mountains, south of Monterey Bay. In 1932, Whitfield published articles dealing with transpiration in the Pike's Peak and Santa Barbara regions, and with osmotic values in several plant communities, also near Santa Barbara. In the same year, Copeland found high rates of transpiration in certain chaparral species of the Sierra Nevada, and Shapiro and de Forest showed that the structural modifications of the leaves of seven out of eight species of the chaparral plants of the Santa Monica Mountains could not be correlated with the rate of water loss by the plants. Bauer (1936) studied environmental factors in chaparral, also in the Santa Monica Mountains, and related these factors to the response of the vegetation. De Forest and Miller (1941) analyzed the environmental conditions in the eastern portion of this same mountain range.

A number of other authors considered aspects of chaparral other than its ecology. The earliest descriptive accounts were by foresters. Barber (1899) and Leiberg (1899, 1900) gave numerous observational data on what were then southern California forest reserves. L. C. Miller (1906) and Munns (1916, 1919, 1920) considered chaparral chiefly in relation to erosion control. Plummer (1911) reported the extent of the chaparral in four reserves with the percentages of dominant species and their vertical ranges, both determined observationally. Other authors also gave accounts of chaparral and the area it covers. Among the Europeans, Schimper (1903) was the first to describe this formation, and to show its similarity to the vegetation of four other areas with the mediterranean climate, though McKinney (1901) had previously written about certain types of chaparral in Orange County, California. Among the Americans, Hall (1902) applied the Life Zones of Merriam to the vegetation of the San Jacinto Mountains, and Grinnell (1908) made a similar survey in the San Bernardino Mountains. Parish (1903) described the physical conditions of the southern California area, but only mentioned chaparral. Abrams (1910) outlined the physiography, climatology, and phytogeographic features of the same region.

The Area

Location and Topography

The area in which this investigation was carried on lies on the southern face of the San Gabriel mountains, about midway on the San Gabriel-San Bernardino mountain front. Its natural boundaries are San Antonio Canyon on the east, San Gabriel Canyon on the west, the east fork of San Gabriel Canyon and its continuations, Cattle Canyon and Cow Canyon on the north, and the plain extending to the Pacific Ocean on the south. Within this area

is included the San Dimas Experimental Forest, operated by the Forest Service, U. S. Department of Agriculture, through the California Forest and Range Experiment Station. The stations used in this investigation were either included in the Experimental Forest or just outside its boundaries. Accessibility was afforded by many roads and trails, while protection was provided by most of the area being closed to the general public.

The geology of the San Gabriel mountains is described in general terms by Leiberg (1900), and in greater detail by W. J. Miller (1929). This rugged mountain mass with its highest peak over 8000 feet, is a single, recently uplifted fault block of crystalline rocks, deeply dissected by steep-walled canyons of depths up to several thousand feet. Apparently, during the uplift, stresses found partial relief in the formation of a great many fractures which run in all directions. This fracturing has resulted in the formation of fault zones rather than definite single faults.

The area described occurs on what Miller calls the middle-southern fault block, and is not traversed by any of the major fault zones, though lesser faults occur in San Dimas, Big Dalton, and other canyons. This has resulted in the formation of soils which, while shallow, immature, and not of the same texture, are residual and of similar development. All of the soils encountered in the digging of pits for soil temperature measurement, and in the collection of soil samples for water content determination, were derived from either igneous or metamorphic rocks, though soils of very different texture may occur within a few feet.

SITES OF STATIONS

To determine the effects of altitude and slope exposure on environmental conditions, five pairs of stations spaced at intervals of roughly 1000 feet in elevation, were established on north and south slopes in typical chaparral of the characteristic altitudinal zones. All accessible sites were marked on a contour map, and selection was made on the basis of the vegetative cover, after visiting each, following the belief expressed by Clements in 1920 that the plant is a measure of the conditions under which it grows. Sites which showed recent disturbances due to fire or other causes were eliminated. In all cases the stations chosen were near ridge-tops, opposite sides of the same ridge being selected whenever possible to eliminate differences due to the distance separating the stations. This practice of locating stations near ridge-tops was considered permissible in light of Clements' previously mentioned statement, so long as the vegetation in which the station was placed was very similar in height, density, and composition to that which extended down the slope below each station.

The Vegetation

The vegetation of this portion of the San Gabriel Mountains consists chiefly of what is called coastal chaparral by Clements (1920), and hard chaparral by Jepson (1925), and occurs almost entirely within the cool summer mediterranean climate (Csb) of Köppen. Along the basal portion there

TABLE 1.—Summary of Data on Stations.

Station	Elevation-Feet	Slope		Vegetation	Character of Substratum
		Degree	Exposure		
1	1300	36°	S 24°W	Coastal sagebrush	Coarse decomposed granite soil with broken rock. Little litter and humus.
2	1250	20.5°	N 36°W	Scrub oak type chaparral	Rich soil with much litter and humus to 50 cm., becoming clay below.
3	2580	33°	S 21°E	Adenostoma type chaparral	Loose decomposed granite soil over broken rock. Little litter and humus.
4	2650	30°	N 26°W	Mixed chaparral species	Shallow soil with much litter and some humus over broken rock.
5	3450	31°	S 13°E	Adenostoma-Ceanothus chaparral	Decomposed granite soil with little litter and humus. Outcrops of decomposed metamorphic rock forming fine soil in spots.
6	3500	28°	N 33°W	Quercus-Ceanothus chaparral	Decomposed granite soil with much litter and some humus over dense decomposed granite at about 50 centimeters.
7	4300	20°	S 16°E	Adenostoma-Ceanothus chaparral	Decomposed granite soil with some litter but little humus over dense decomposed granite at about 15 centimeters.
8	4400	37°	N 20°W	Ecotone between Quercus woodland and mixed chaparral	Decomposed granite soil with considerable litter and some humus over broken rock.
9	5400	37°	S 16°W	Ceanothus-Arctostaphylos chaparral	Decomposed granite soil about 30 cm. deep over dense decomposed granite. Much liter and some humus.
10	5500	35°	N 43°W	Quercus woodland	Decomposed greiss soil with some litter and humus. Frequent rock outcrops.

is, however, an extremely broken belt containing *Artemisia californica* Less.,[1] *Eriogonum fasciculatum* Benth., and *Salvia mellifera* Greene, which according to Clements (1920) characterize climax coastal sagebrush. The area lies within what Cooper (1922) describes as one of the centers of distribution of broad-sclerophyll scrub, though more recent work by Epling and Lewis (1942), who eliminated broad-sclerophyll woodland and considered only the distribution of chaparral and coastal sage associations, found the center of distribution to be somewhat to the south in San Diego County and northern Lower California. The coastal sage community occurs only on the steeper and more exposed sites with southerly exposure, alternating with the riparian association of the canyon bottoms, with broad-sclerophyll woodland of *Quercus agrifolia* Nee. on level spots or gentle northerly slopes, or with a dense scrub of *Quercus dumosa* Nutt., *Cercocarpus betuloides* Nutt. and *Fraxinus dipetala* H and A. on steeper, northerly slopes. The change from one type of vegetation to another is abrupt, with practically no intermingling of species.

With increase in elevation, however, the change from this form to chaparral on south-facing slopes is so gradual as to be scarcely noticeable. *Artemisia californica* drops out first, and scattered individuals of *Adenostoma fasciculatum* H and A. begin to appear. On the steeper, more exposed slopes at 2500 feet, *Eriogonum fasciculatum* increases and *Salvia mellifera* is still present, though they have disappeared from the more favorable sites. At 3500 feet, they are rare, being replaced by *Adenostoma fasciculatum*, which in this area does not form pure stands, and by *Ceanothus crassifolius* Torr., which is its codominant throughout this approximate altitude. These species are gradually replaced by *Ceanothus divaricatus* Nutt. and a smaller amount of *Arctostaphylos glandulosa* Eastw. between 4500 and 5000 feet elevation. The scattered clumps of oaks—*Quercus chrysolepis* Liebm. and *Q. wislizenii* var. *frutescens* Engelm. which appear on the southerly face of Sunset Peak (elev. 5820 feet), the highest point in the area, indicate that this portion of the chaparral might be subclimax. Throughout these zones the physiognomy remains about the same, the stands being 1 to 2 meters in height and generally uniform. However, the density increases markedly in the more elevated portion.

The codominance of *Ceanothus crassifolius* and *Adenostoma fasciculatum* instead of the characteristic pure stands of the latter may be explained by observations made by J. S. Horton of the staff of the San Dimas Experimental Station. He found that the relative percentage of individuals of *A. fasciculatum* is greater in a small portion of the area which was not burned in the last fire (date unknown) than it is in the portion which was burned. He concluded that *Ceanothus crassifolius* comes in after fire, but does not reproduce when in competition with *A. fasciculatum*. The rather large number of dead individuals of *C. crassifolius* found on the line transects at Stations 5

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1 The nomenclature throughout this paper follows Jepson (1925). Citations of authority for scientific names are given with the first appearance of each name and are not repeated thereafter.

and 7 lend support to the theory. However, J. S. Horton and H. G. Wilm, then a member of the same staff, examined 100 milacre quadrats without finding a seedling of either of these species.[2]

On northerly slopes where moisture conditions are less critical, the individual plants are from 3 to 4 meters tall and the appearance of uniformity in height is lacking. The shrubs are usually so closely placed with branches so interlaced that passage is difficult. However, both of these effects may be the result of growth after fire, for in the chaparral of San Dimas Canyon which has not been burned for at least fifty years, the shrubs are well spaced and *Quercus dumosa* takes on tree form producing a canopy beneath which there is little undergrowth.

At about 2000 feet elevation, there is a broad transition between the species found at the lower elevations and those which comprise the bulk of north-slope vegetation. There is no change in physiognomy and definite dominance is lacking. But at about 4000 feet, there occurs a second transition, in this case with a change in physiognomy. *Quercus chrysolepis* which has been an important component of the tall scrub takes on tree form and assumes dominance. The ecotone, therefore, is one between chaparral and broad-sclerophyll woodland, but without the introduction of new species. The number of trees increases until at about 5000 feet there is almost a pure stand of *Q. chrysolepis* forming an unsually dense woodland. Standing groups and scattered individuals of *Pseudotsuga macrocarpa* Mayr. with fire-blackened trunks, and some charred fallen trees indicate that a forest of this conifer might have covered this portion of the mountain. In some places among the remaining conifers, replacement of chaparral by the oak woodland and the absence of oaks of maximum size add evidence to this idea, first suggested by Leiberg in 1899.

To verify estimates of dominance, line transects were run at nine of the ten stations employed. The intention was to run a straight line 100 meters in length at each station down the slope through the station site, but this plan had to be modified where short slopes prevented its application. In these cases, several shorter lines were run parallel to each other, and at Stations 3 and 4, the length of the lines had to be reduced. At Station 9 no transect was made as the growth of *Ceanothus divaricatus* proved impenetrable, and the dominance of this species and *Arctostaphylos glandulosa* was obvious. In all, 800 meters of transect were made. Tables 2 and 3 summarize the data obtained from these transects. The figures given representing the number of individuals of each species touching the line expressed as per cent of the total number of individuals of all species in contact with the line. Because the extensive intermingling of branches made it very difficult to determine the extent of the crowns of individual shrubs, no attempt was made to measure comparative areas covered by each species. The species used for the measurement of growth are designated by asterisks.

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2 From unpublished data supplied by J. S. Horton and H. G. Wilm.

Environmental Conditions

RAINFALL

The rainfall data used in the following sections was obtained from records of eight Forest Service gauges located near several of the stations. These gauges were read immediately after each storm and sometimes during storms, or were recording instruments of various types. The averages presented in Figure 1 are calculated from records of these Forest Service gauges, and are compared with a 45-year average for Glendora, California, which is located at the base of the foothills southwest of the area employed, and lies within nine miles of the most distant station. These latter records were furnished by the Weather Bureau, U. S. D. A.

The 45-year average for Glendora shows almost a normal curve with 75 per cent of the precipitation occurring in the four months of December through March. The records for the individual years show concentration in the same four months, but otherwise present a very different picture. In the year 1935-1936, 61 per cent of the rainfall was recorded in the month of February. In 1936-1937, the rainfall was more evenly distributed with the heaviest precipitation occurring in December.

TABLE 2.—Percentage of Species Touching Line Transect at Stations with Southerly Exposure, with Length of Line Run.

Species	Station 1 100 m.	Station 3 70 m.	Station 5 100 m.	Station 7 100 m.
Artemisia californica	20.0			
**Salvia apiana*	10.7			
**S. mellifera*	36.4	12.9	8.8	
Eriogonum fasciculatum var. *foliolosum*	5.7	35.5		
Diplacus longiflorus	7.0			
Brickelia californica	14.3			
Elymus condensatus	3.6			
Yucca whipplei	2.9			
Rhamnus crocea var. *illicifolia*	0.7	3.2		
Prunus illicifolia	0.7			
**Adenostoma fasciculatum*		45.2	31.8	58.1
**Ceanothus crassifolius*		1.6	47.6	31.8
**Cercocarpus betuloides*		1.6		
Rhus ovata			2.4	
**Arctostaphylos glandulosa*			0.8	5.5
A. glauca			3.2	4.5
Eriodictyon californicum			3.2	
Bare ground	13.0	8.2	11.0	2.5*

*Bare ground found only where plants have died.

TABLE 3.—Percentage of Species Touching Line Transect at Stations with Northerly Exposure, with Length of Lines Run.

Species	Station 2 100 m.	Station 4 60 m.	Station 6 100 m.	Station 8 100 m.	Station 10 100 m.
**Quercus dumosa*	41.7	17.4			
Photinea arbutifolia	8.7		3.6		
Fraxinus dipetala	31.5				
**Cercocarpus betuloides*	12.7	5.9			
Rhus diversiloba	7.1				
Ribes californica var. *hesperium*	3.2				
**Ceanothus oliganthus*		17.4	57.8	6.3	
**Quercus wislizenii* var. *frutescens*		17.4	34.9	17.7	
**Q. chrysolepis*		12.8	1.2	56.6	96.9
**Adenostoma fasciculatum*		9.3			
Arctostaphylos glandulosa		9.3		10.1	
A. glauca		2.3			
**Ceanothus crassifolius*		7.0			
Umbellularia californica		1.2			
Rhus ovata			2.4	1.3	
**Ceanothus divaricatus*				8.9	
C. integerrimus					1.5
Pseudotsuga macrocarpa					1.5
Bare ground	1.5			6.5*	10.0*

* Bare ground found only where plants have died.

In 1937-1938, even greater extremes occurred. The highest rainfall in many years occurred in one storm, from February 27 to March 3, when an average of 17.07 inches was recorded by the eight Forest Service gauges. This does not show in Fig. 1, because the rainfall was prorated to provide monthly averages. This storm was so severe that it washed out all roads thus causing an interruption in the records. Serious floods were caused on the plain at the foot of the mountains, and great damage was done. However, in the chaparral itself, no signs of the severity were noted, as the dense cover and the litter prevented rapid surface runoff and allowed the water to enter the ground. But, as the soil soon became saturated, the ground water rapidly entered ravines and stream courses which were quickly cut to bed rock.

Table 4 summarizes some of the rainfall data not indicated in the graphs. All comparisons with the 45-year average at Glandora must be considered as purely qualitative, as differences in altitude render quantitative conclusions invalid.

In addition to the irregularity in occurrence and intensity of storms, there was considerable variation in the amounts or precipitation collected at different sites during a single storm. This variation might correlate with elevation,

exposure of gauges, and the direction of the wind during the storm, but with the data at hand, such a correlation is impossible.

EVAPORATION

The study of evaporation was made with white standardized Livingston spherical porous cup atmometers placed with the centers of the spheres about 30 centimeters above the ground level. This was done because an investigation by Bauer (1936) indicated that the evaporation rates at this height were intermediate between those at the upper level of the vegetation and at one meter above the ground, where the density of chaparral is usually great. The atmometer supply bottles were equipped with rain-proof valves and the spheres were washed with distilled water at each refilling of the bottles (Livingston, 1935).

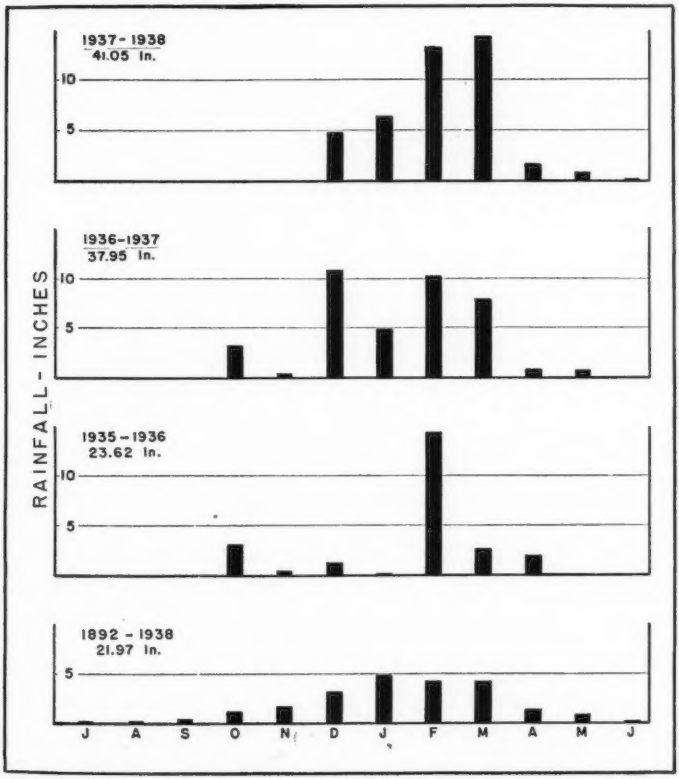

Fig.1.—Monthly rainfall averages for eight Forest Service rain gauges located near the sites of stations, compared with the forty-five year average for Glendora, California.

However, a series of tests showed that the amount of dust and algae accumulating on the atmometer spheres in a two-week interval did not change their evaporation rates beyond the error permissible in standardization. The instruments were replaced and restandardized whenever a change between the evaporation rates of the two atmometer spheres at each station occurred. Though a number of the spheres were broken by cold and so could not be restandardized, only one undamaged bulb showed a change in coefficient greater than the limit of error permitted in restandardization.

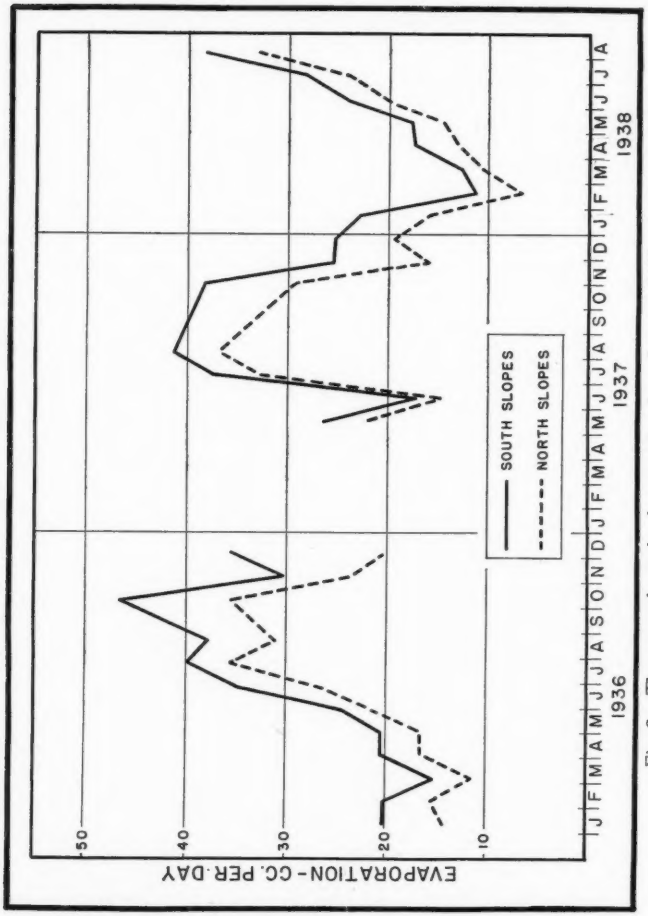

Fig. 2.—The seasonal march of evaporation from January, 1935, to August, 1938, for stations on northerly and southerly slopes, averaged by four week intervals.

The five pairs of stations were in operation from November 30, 1935, to August 6, 1938, with readings taken at two week-intervals for the most part. All records were interrupted in the spring of 1937 due to extreme cold which broke all atmometer spheres and prevented their successful replacement for about four months. For the same reason, no records of evaporation rates were obtainable at the pair of stations at the highest elevation from the time of the first frosts until minimum temperatures rose above the freezing point in April or May. The records were broken again in the late summer to permit the restandardization of the atmometer spheres. Losses of individual readings occasionally occurred due to damage to the spheres by cold, storms, animals, or to the evaporation of all the water contained in the supply bottles.

TABLE 4.—Summary of Rainfall Data.

	1935-1936	1936-1937	1937-1938
Total Rainfall	23.62	37.95	41.05
Number of Storms	15	20	18
Month of Heaviest Storm	February	December	February-March
Highest percentage in a Single Storm	41.9	21.3	41.6
Date of First Rainfall over 0.25 Inch	Nov. 17	Oct. 16-18	Dec. 9-12
Date of Last Rainfall over 0.25 Inch	Apr. 3	May 27-30	June 9-12

Because readings were occasionally made at other than two-week intervals, and for ease in manipulation, the readings were converted into weekly intervals and then changed to daily evaporation rates. Figure 2 shows the seasonal march of evaporation for stations on north and south-facing slopes arranged by four-week intervals. Because of this averaging it must be borne in mind that the detail of the individual graphs is determined by the arbitrary selection of the first interval. Had an earlier or a later starting date been selected, it is probable that only the general trends shown by the graphs would remain unmodified. The average evaporation rates for the southerly slopes were consistently higher, and variations occurred together except in one case. While the divergence of evaporation rates appears greater during the summer than during the winter, the relative rates remain practically constant. The higher evaporation rates observed on southerly slopes are the results of several factors. Topographically these slopes are more completely exposed to sun and wind than are northerly slopes, as the effect of insolation was negligible on the latter, and the prevailing winds blow from west to southwest about eight months of the year. Both these effects are increased by the lesser height and density of the vegetative cover on southerly slopes.

The seasonal march of evaporation is about what is to be expected in a mediterranean climate which has hot, dry summers, and cold, wet winters.

The maximum evaporation rates for two-week intervals occurred July 12-25, 1936, and August 1-14, 1937, with the last recorded interval in 1938 being the highest of that year. The first of these maxima is not indicated in Figure 2, as it was suppressed in the averaging. The considerable variation in evaporation rates from interval to internal is also suppressed by the averaging. A statistical analysis of these variations shows a range of from 82 per cent above the mean to 240 per cent below the mean, with a standard deviation of 52.2 per cent. The greatest single variation from one interval to the next was one of 291 per cent. The work of Cooper (1922), Bauer (1936), and de Forest and Miller (1941), indicates that this considerable fluctuation is characteristic of evaporation rates in chaparral.

Figure 3 indicates the effect of altitude and slope exposure on the evaporation rates. Because of breakage of the atmometer spheres due to cold at the highest altitude, the records of all five pairs of stations could not be com-

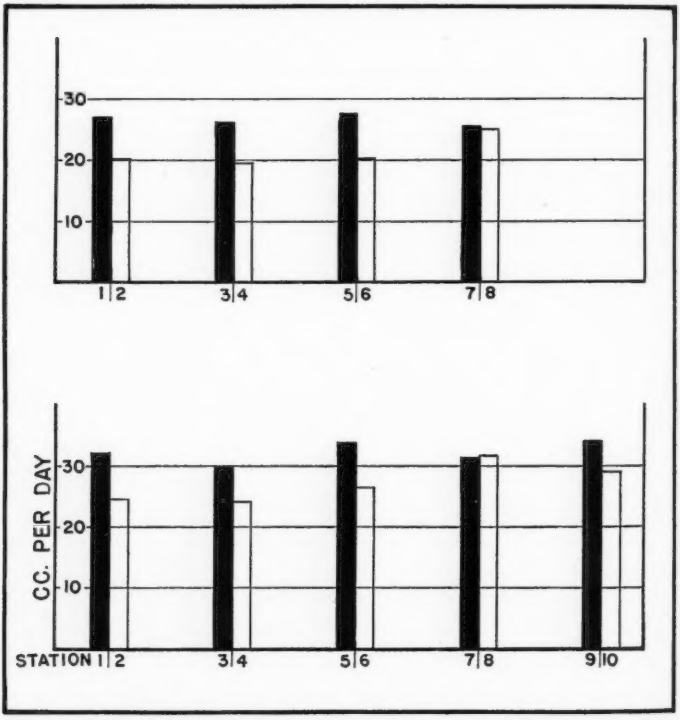

Fig. 3.—Average evaporation rates at 10 stations; upper figure from December, 1935, to August, 1938, and lower figure from May through November of 1936 and of 1937, and from May through July of 1938.

pared directly. This necessitated the construction of two figures, the upper one comparing the evaporation rates for the entire period at all stations except the pair at the greates elevation, and the lower giving the evaporation rates for the highest pair of stations with comparable portions of the records of the other stations.

The most notable feature shown by these graphs is the fact that altitude has no important effect on the evaporation rate. In the upper figure, there is certainly no increase in southerly slopes with increase in elevation, nor with an increase of 2000 feet on northerly slopes. The unexpectedly high evaporation rate at Station 8 on the north slope at 4500 feet elevation is significant, but can be explained at least in part by the exposure of the station. It was located on a small ridge with a saddle on either side so that it was exposed to winds from three directions—a much more exposed site than any other station on a northerly slope. This is borne out on the lower graph of Figure 3 by comparison with the evaporation rates at Stations 9 and 10 at 5500 feet elevation.This figure, which does not include the winter months, shows a slight increase in evaporation with altitude but hardly a significant one. The southerly slopes have higher evaporation rates with the exception already noted, the average being 15 per cent greater.

AIR TEMPERATURE

Air temperatures were obtained at each station by means of a maximum-minimum thermometer placed under a small shelter at a height of about 30 centimeters above the level of the soil, to obtain temperature measurements at the same height as the atmometer spheres. The proximity to the ground undoubtedly caused higher maximum temperature readings than would have been recorded at a greater height, because of reflection of heat from the soil. This difference was confirmed but no attempt was made to measure the increase.

The maximum, minimum, and current temperatures were read at each visit to the stations. Mid-points between maximum and minimum readings for each interval were calculated and considered to be the mean temperatures. Figure 4 compares average maximum, average minimum, and mean temperatures for the five pairs of stations for the entire period of the investigation. The vertical bars represent the temperature range at each station, with the horizontal line crossing each bar near its center indicating the mean temperature. As would be expected, both the average maximum and mean temperatures on southerly slopes are higher than on northerly slopes at corresponding altitudes, the differences remaining about the same except in the case of the lowest pair of stations. The mean temperatures at stations on southerly slopes exceed those on northerly slopes by an average of 21.0 per cent. A decrease in mean temperature with increased altitude is also apparent. The calculated decrease in temperature due to increased altitude, based on a decrease of 1 degree C. for each 180 meters of elevation (Humphries, 1920), is indicated by dotted lines which are arbitrarily made to coincide with the mean temperatures of the central pair of stations. The difference between the observed and calculated

TABLE 5.—Extremes of Air Temperature Averaged for Stations on Southerly and Northerly Exposures.

	Minima	Maxima	Range	Highest Minima	Lowest Maxima	Absolute Range	Extreme Range from Interval to Interval	
							Greatest Range	Smallest* Range
Southerly Exposures, Deg. C.	35.9	4.4	31.5	46.1	–4.8	50.9	36.9	28.3
Northerly Exposures, Deg. C.	26.6	4.6	22.0	38.5	–4.6	42.1	23.1	13.5
Per cent of Difference	25.8	4.4	30.2	16.5	4.2	17.3	37.4	52.2

* Station 10 omitted in 1937 and 1938.

rates of decrease is less than a degree except in the case of the lowest pair of stations. These latter stations were situated on a low, east-west ridge around which San Dimas Canyon bends. Cold air draining down the canyon would probably flow directly over them, a fact which may account for this divergence.

Figure 5 shows the seasonal march of air temperature on northerly and southerly slopes. As was indicated in Figure 4, the temperatures on southerly slopes are seen to be consistently higher than those on northerly slopes, and in most cases, the variations occur together. The winter of 1936 was the warmest of the three years, with the highest mean maximum and minimum temperatures, as well as the greatest temperature range. The year 1937 had the lowest mean maxima and minima. The winter of 1936-1937 was particularly severe, January having the lowest monthly average recorded by the Los Angeles office of the Weather Bureau, U. S. D. A., since its establishment in 1877. Some

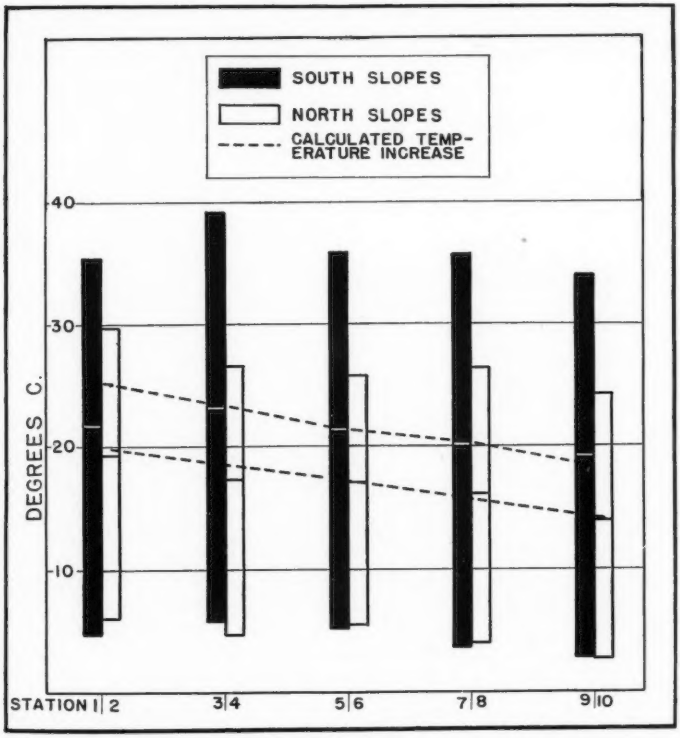

Fig. 4.—Average maximum, average minimum, and mean air temperature at 10 stations, from December, 1935, to August, 1938.

damage was done to vegetation by the freezing of the tips of shoots and particularly of the flower buds of plants in exposed sites.

Because extreme conditions must be of great importance to plants, Table 5 was made to permit the comparison of the ranges of air temperature on southerly and northerly slopes. Air temperatures showed greater variability on southerly than on northerly exposures, for while the minimum temperatures

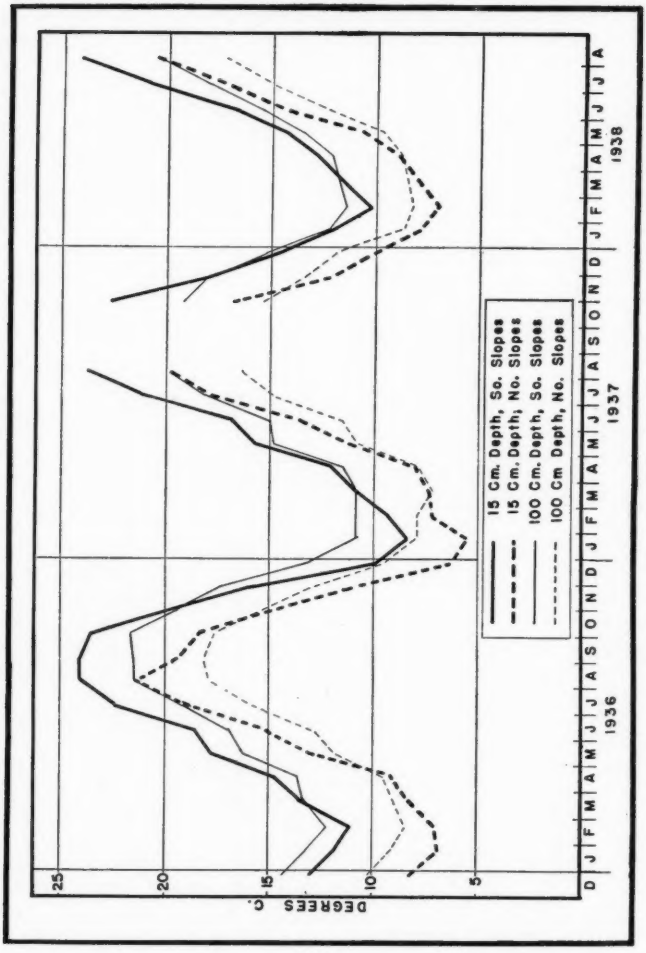
15 Cm. Depth, So. Slopes
15 Cm. Depth, No. Slopes
100 Cm. Depth, So. Slopes
100 Cm Depth, No. Slopes
DEGREES C.
25
20
15
10
5
D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A
1936
1937
1938

Fig. 5.—The seasonal march of mean air temperature on northerly and southerly slopes by four week intervals, from January, 1936, to August, 1938.

were about the same, the maxima and consequently the temperature ranges on southerly slopes were considerably greater. The mean range on southerly slopes was found to be 30.2 per cent greater than on northerly slopes. In the comparison of ranges from one observation date to the next, there was an even greater difference, the greatest range being 37.4 per cent greater on southerly than on northerly exposures, while the smallest range on southerly slopes was 52.2 per cent greater than the smallest range on northerly slopes.

No study of daily temperature ranges was possible in the investigation, but the Forest Service has supplied data for the San Gabriel Divide Climatic Station which is situated just above Station 7 at 4350 feet elevation on a southerly slope. The mean daily ranges are identical in 1936 and 1938 (10.9 degrees C.), and slightly higher in 1937 (11.6 degrees C.). The smallest range was the same in each of the three years (1.7 degrees C.). The greatest range was largest in 1937 and smallest in 1938, but the difference was only 1.1 degrees C. It is interesting to note that the greatest range occurred during the growing season in each of the three years, though in 1938 it was equalled twice in the latter part of August, and that the smallest range in that year occurred just three days after the first occurrence of the greatest range.

SOIL TEMPERATURE

Soil temperatures were taken at each station at depths of 15, 30, 60, and 100 centimeters by a modification of the method described by Toumey and Stickel (1925). Redwood boxes were sunk into the ground, and tunnels were extended horizontally from the boxes into the soil at the depths mentioned above. The top and sides of these tunnels were supported by boards, but the bottoms were left open to permit the thermometers to be in direct contact with the soil. The tunnels were closed to eliminate air circulation, and the boxes were covered by closely fitting lids of two layers of one inch redwood to reduce the effect of air temperature and insolation. Maximum-minimum thermometers were kept in the tunnels at 15 centimeters in depth from December, 1935, to September, 1937, with chemical thermometers used at the other depths when the stations were visited. From September, 1937, until August, 1938, the maximum-minimum thermometers were kept in the four tunnels of each soil box at a pair of stations for about two months, then the thermometers were moved to the next pair of stations for a like period. This procedure permitted the determination of the temperature range at each depth of the soil during some part of the investigation.

While current temperatures only were obtained at depths greater than 15 centimeters for the larger part of the investigation, their use in the analysis of soil temperatures appears to be justified because of the small differences between the mean temperature of the interval between observations and the current temperature at the time of reading. Table 6 indicates that even at the 15 centimeter depth the standard deviation of the current temperature from the mean temperature is only 1.79 degrees C. At 30 centimeters depth the greatest difference from the mean is only 2.5 degrees C. and at greater depths is even less. It is doubtful that such slight differences can be of significance to plants.

The table indicates that the statistical mean of current temperatures is slightly lower than the difference between the maximum and minimum temperatures which is taken as the mean temperature.

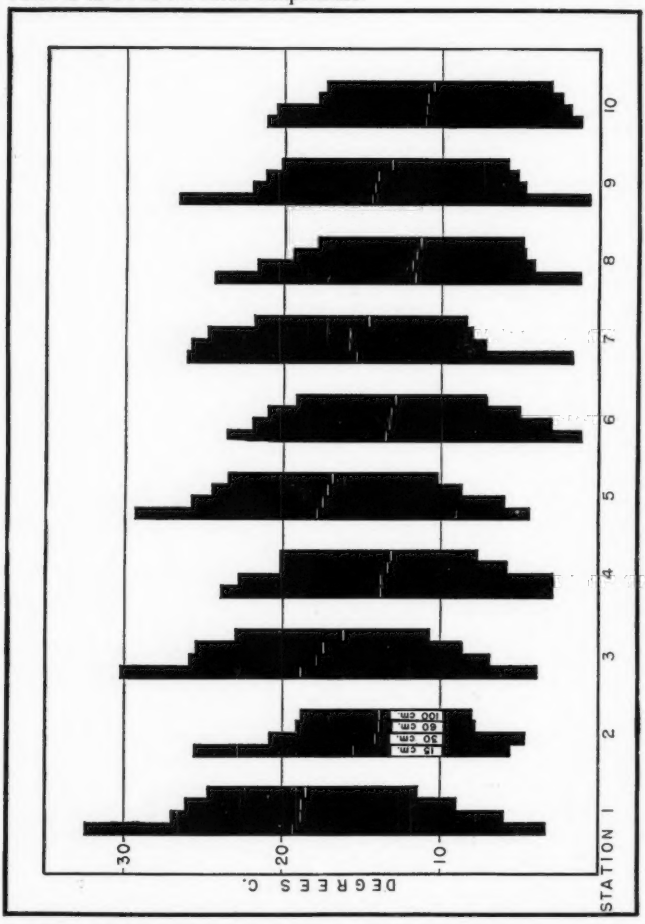

Fig. 6.—Average maximum, minimum, and mean soil temperatures at depths of 15, 30, 60, and 100 centimeters, from December, 1935, to August, 1938.

Figure 6 shows maximum, minimum and mean soil temperatures at depths of 15, 30, 60, and 100 centimeters for the period from December, 1935, to August, 1938. As would be expected, the soil temperatures were reduced with increased altitude. However, reduction in temperature was not as great as in the case of air temperatures, which compared very closely with the calculated temperature reduction with increased altitude. The calculated decrease averaged

1.77 degrees C. from station to station, and the reduction in air temperature averaged 1.75 degrees C., but the soil temperature reduction averaged 1.04 degrees C. Also as in the case of air temperatures, the slope exposure had a marked effect on soil temperatures. The temperatures on northerly exposures were consistently lower than those on the southerly slopes, the differences averaging 23.6 per cent. These differences are approximately the same as the air temperature differences which averaged 21.0 per cent.

TABLE 6.—Divergence of Current Temperatures from Mean Soil Temperatures at Four Depths.

Depth	Number of Cases	Divergence of Current Temperature Mean	Standard Deviation	Range	
				Above Mean Temperature	Below Mean Temperature
Cm.		Degrees	Centigrade		
15	414	−0.55	1.79	5.9	5.3
30	22	−0.36	1.17	2.5	1.9
60	25	−0.48	0.32	1.4	1.8
100	25	−0.48	0.27	1.7	1.3

The range of soil temperatures was considerably reduced with increased soil depth. The range at 100 centimeters in depth was about half (54.2 per cent) of the 15 centimeter range. However, the difference in ranges would have been smaller had current temperatures been used for both the 15 and 100 centimeter depths instead of using maximum and minimum values for the 15 centimeter level. The average temperature ranges on northerly slopes were 11.2 per cent less those on southerly slopes.

Figure 7 shows the seasonal march of soil temperatures at 15 and 100 centimeters depth on northerly and southerly exposures, averaged by four-week intervals for the period from December, 1935, to August, 1938. As in the case of air temperatures, the soil temperatures on southerly slopes were consistently higher than those on northerly slopes, the difference remaining relatively constant. The effect of the depth of soil was greater than the effect of slope exposure in determining the shape of the graphs, the 15 centimeter graphs forming one pattern, and the 100 centimeter graphs forming a somewhat different one. This effect seems to have been produced by the increasing lag in the response to variations in air temperature with increased soil depth.

The temperature range at 100 centimeters depth was less than at 15 centimeters, with lower maxima and higher minima. Consequently, the two graphs for the same slope exposure had to cross as they rose to summer maxima and fell to winter minima. Due to averaging, the graphs indicate that these crossings took place soon after the upward or downward trend occurred, but actually the

dates of the crossings were extremely variable, from four to eight months being required for the shift to occur at all stations. This variability does not seem to correlate definitely with either slope exposure or elevation.

As in the case of air temperatures, 1936 was the warmest and 1937 the coolest of the three years. The mean soil temperatures at the different depths were about the same for each year with a tendency to be somewhat lower at greater depths. The soil temperatures were 23.4 per cent lower on northerly exposures than on southerly exposures. The temperature range averages for each of the three years showed a reduced range at each successive depth of

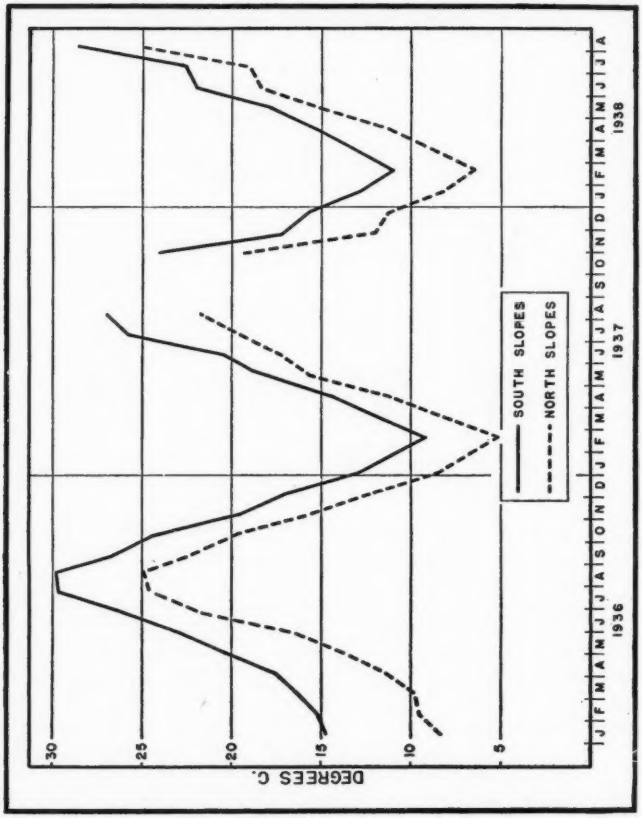

Fig. 7.—The seasonal march of soil temperatures at 15 and 100 centimeters depth on northerly and southerly slopes, averaged by four week intervals, from December, 1935, to August, 1938.

soil and a slightly reduced range at each comparable depth on northerly as compared with southerly exposures. These average ranges are given in Table 7.

TABLE 7.—Average Temperature Ranges at Four Depths of Soil from January, 1936, to August 6, 1938.

Exposure	Range	Depth in Centimeters			
		15	30	60	100
Southerly Exposures	Degrees C.	17.8	16.1	14.0	10.9
	Per cent	100.0	90.4	78.6	61.2
Northerly Exposures	Degrees C.	16.5	15.6	12.8	10.5
	Per cent	92.5	87.6	71.8	59.0

SOIL MOISTURE

Soil samples for moisture determination were taken at depths of 15, 30, 60, and 100 centimeters at each station at intervals of about two weeks. While it would have been desirable to have dug trenches from the sides of which the soil samples might be taken, this proved impractical due to the character of the soil. So, samples were taken by means of a soil tube which when driven into the ground to the desired depth, removes a core of soil (Veihmeyer, 1935). Because of the difficulty of removing this core intact and of determining the exact depth from which each part of the core had come due to the compacting of the soil in the tube, it became the practice to drive the tube to the proper depth for the first sample, remove the tube from the soil, unscrew the removable bit and retain only the soil contained in the bit as the sample. The bit was then replaced, the soil tube inserted in the same hole, and the second, third, and fourth samples secured in the same way. This gave cylindrical samples roughly three inches long by one inch in diameter with their centers from the desired depth. Because of the difficulty in driving the tube into the rocky soil and removing it without shaking out the core, only a single sample was obtained for each depth at each station. The samples were placed in small screw-cap glass bottles and dried at 100 to 110 degrees C. for at least 48 hours, the moisture content being expressed as percentage of dry weight.

As two days usually elapsed before the samples could be placed in the drier, the loss of water by evaporation over a six-day period was measured to determine the seriousness of the delay in drying the samples. Since a series of samples containing an average of 21 per cent of moisture lost an average of only 0.6 per cent in the rather high air temperatures of August, it was assumed that the loss of soil moisture due to evaporation from the sample bottles in two days would not affect conclusions drawn concerning the moisture content of the soil.

WILTING POINTS

While the wilting of plants occurs over a considerable range of soil moisture tensions, Richards and Weaver[3] have shown that the moisture which is retained by the soil at a tension of 15 atmospheres is ordinarily a reliable index of the wilting point. The wilting points employed in this investigation are these 15

[3] From an unpublished paper referred to by Magistad and Reitemeier (1943).

atmosphere wilting points, and were determined by E. A. Coleman of the staff of the San Dimas Experimental Forest, using a slight modification of the apparatus described by Richards (1941). Twenty gram samples of air dry soil in quadruplicate were placed in short sections of rubber hose on the pressure membrane of Visking. The soils were saturated from below and the excess water pipetted off after one hour. Nitrogen pressure of 15 atmospheres was applied and maintained for 48 hours. The rubber membrane which Richards placed over the samples to keep the soils in contact with the pressure membrane was not used, as satisfactory results had been obtained without it. The wilting points or wilting percentages referred to hereafter are 15 atmosphere wilting points.

Figure 8 shows the seasonal march of soil moisture at depths of 15 and 100 centimeters for the period from June 6, 1936, to August 6, 1938. The two horizontal lines represent the average of the wilting points for the same depths as the soil moisture samples. At the bottom of the graph is a series of

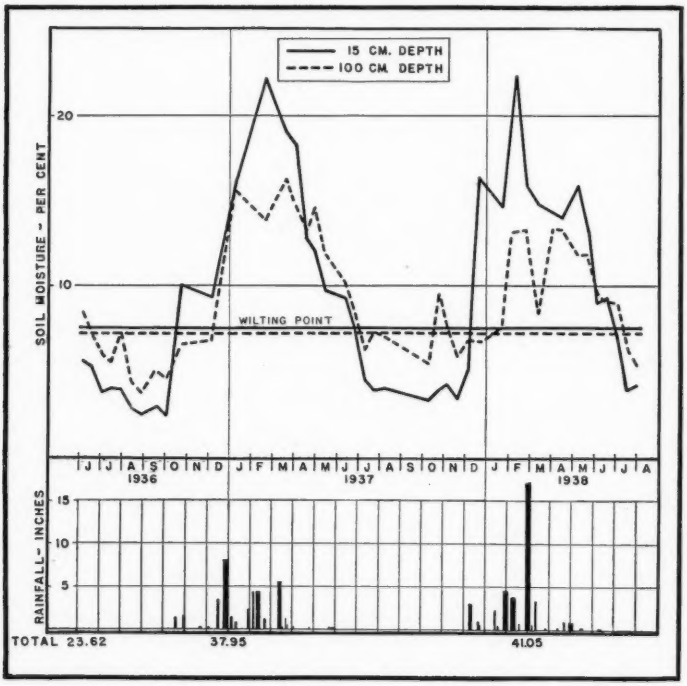

Fig. 8.—Average percentage of soil moisture and the wilting point at depths of 15 and 100 centimeters, from June, 1936, to August, 1938. Rainfall data from eight Forest Service rain gauges.

bars representing the average precipitation caught by eight Forest Service rain gauges located near several of the stations. The height of the bars indicate the amount of precipitation, and the width, the duration of the storm. The most noticeable feature of the graphs is the extreme variability of soil moisture even when no rain had fallen, a condition probably due to the difference in soil texture in spots only a short distance apart.

In the summer of 1936 all soils except one at 100 centimeters depth at Station 8 dropped below the wilting point, the average at 15 centimeters from June 6 through October 3 being only 3.8 per cent, which was exactly one-half of the wilting percentage. The average moisture content at 100 centimeters for the same period was 5.9 per cent. After the first rain on October 16-18, the soil moisture contents at 15 centimeters rose sharply, but as moisture samples were not taken until six days later, and as the average maximum air temperature was 34.7 degrees C., much of the moisture must have been removed by evaporation or transpiration before the samples were collected. The same is true but to a greater degree in the next interval as samples were not taken until December 5. By the time of the next sampling on January 9, 1937, a total average of 16.88 inches of rain had fallen, and the soil moisture content of all soils was well above the wilting point. The amount of soil moisture began to decrease after the last heavy rain which occurred on March 11-16, 1937, and continued to drop until the summer level was reached. The 15 centimeter average was at the wilting point of 7.6 per cent on May 26, and from that date through December 3, the average was 4.2 per cent. On the other hand, the average for the same period at 100 centimeters was 7.0 per cent, only 0.3 per cent below the average wilting point. This was caused by the fact that while only one depth sampled during the previous summer remained above the wilting point, eight remained above in the summer of 1937 (Figure 10, p. 404).

At the onset of the rainy season of the next year, an abrupt rise similar to that of 1936 occurred. A rainfall of 4.02 inches between the sampling dates of December 3 and 24 raised the moisture content above the wilting point at all 15 and 30 centimeter depths and at several of the 60 centimeter depths. By February 5, 1938, 16.61 inches of rain had fallen and all soils were above the wilting point. An interesting and unexplainable feature is the drop in soil moisture at 100 centimeters depth almost to the wilting point just nine days after a rainfall of 17.07 inches, the heaviest precipitation in many years. The 15 centimeter average was below the wilting point on July 2, and the 100 centimeter average followed during the next two weeks, about a month later than in the previous year.

Figure 9 gives a comparison of the average amounts of moisture present in the soil at depths of 15, 30, 60 and 100 centimeters, during the period from May, 1936, to August, 1938. To make the soil moistures comparable, the percentages were divided by the wilting points of the soils. The figure must be considered to be only qualitative for the following reasons. First, the averages at the four stations with the highest elevations were not as large as

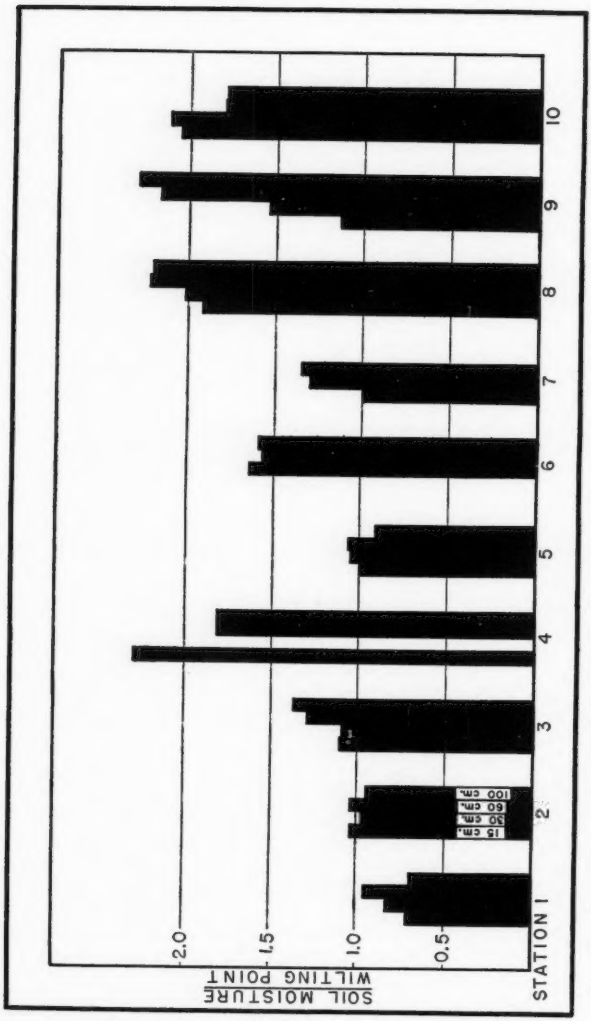

Fig. 9.—Average soil moisture divided by the wilting point at four depths of soil, from May, 1936, to August, 1938.

they should have been because these stations were inaccessible during the wettest periods of 1937 and 1938. Second, some of the wilting points are probably not accurate because of the removal, before the wilting point determinations were made, of the large particles from the decomposed granite which constituted many soils.

The figure shows that southerly slopes formed a drier habitat than northerly slopes, as the ratio of soil moisture to the wilting point was 29.9 per cent lower on the former than on the latter slopes. Differences in air temperature, insolation, and probably air movements would produce this difference. The effect of elevation is also clearly shown, and would have been more definitely marked had complete records been available for the four stations with the highest elevations. Even so, the ratio indicates about twice as much available soil moisture at the three stations with the highest elevations as compared with the two at the lower elevations. Rainfall data indicate that there might be somewhat heavier precipitation at greater elevations, but since the storms occurred on the same dates, and the soil moisture data show that there was sufficient rainfall to saturate all soils at least to the 100 centimeter depth, the drying of all soils would commence at the same time. Inasmuch as the effect of all factors contributing to the evaporation rate except air temperature increases with increased elevation, the greater retention of soil moisture at higher elevations must be the result of the decrease in air temperature.

Figure 10 was designed to show the length of time each soil at each station was above the wilting point, and particularly to permit the comparison of the dates at which each soil moisture fell below the wilting point. The black horizontal bars represent the time during which the soils were above the wilting point. The bars were drawn from the date of the first sampling showing soil moistures above the wilting point regardless of dates of rainfall, except in a few cases. In these cases, the moistures were above the wilting point at only one sampling, and an estimate of the dates of rise and fall was made to permit short bars rather than merely vertical lines to be placed on the figure. At the bottom of the figure is a series of vertical bars representing the average precipitation caught by eight Forest Service rain gauges located near several of the stations. The total precipitation from July through June of each year is given below the vertical bars.

The low rainfall and high temperatures of 1935-1936 are reflected in the length of time the soils remained above the wilting point in that year as compared with the two following years. While soil moisture samples were not taken until May 9 to June 6, 1936, some comparison is possible. The first considerable rainfall of 1935-1936 occurred on December 29, the latest of the three years. The soils at all depths at five of the stations had fallen below the wilting point by the first of June, 1936, while all the soils at only one station in 1937, and at two stations in 1938 had done so. Only one soil sampled remained above the wilting point throughout the summer of 1936, while eight remained above in 1937. As it is certain that there was sufficient precipitation in

1935-1936 to saturate the soils, it is probable that this difference is due to the higher temperatures, rather than to the difference in amount of rainfall. The discontinuance of soil sampling on August 6, 1938, makes it impossible to determine the number of soils which remained above the wilting point during that summer, but the two storms of April 23-25 and April 29-May 5 of that year which brought an average precipitation of 1.94 inches, extended the time at which the majority of the soils dropped below the wilting point into July, which was somewhat later than in the previous year. Evidently 1938 had the longest period with moisture and temperature conditions favorable for growth, though the soil moisture was raised above the wilting point two months earlier in the preceding year. 1935 had the shortest period of favorable soil moisture except possibly at Stations 8, 9, and 10. The greater duration of favorable moisture conditions at these three stations is reflected in the vegetative cover of the slopes upon which they are situated. The climax at Station 8 is broad-

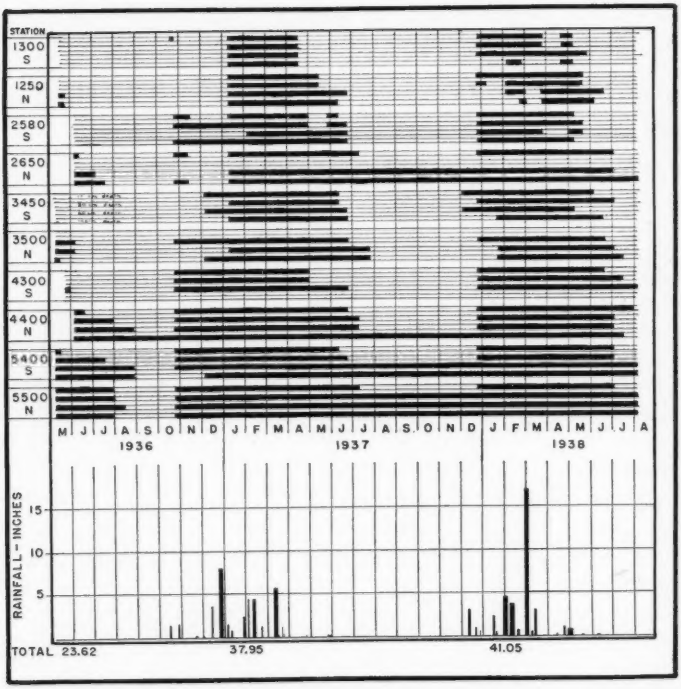

Fig. 10.—The period during which the soil moisture at depths of 15, 30, 60, and 100 centimeters was above the wilting point from May, 1936, to August, 1938. Rainfall data from eight Forest Service rain gauges.

sclerophyll woodland, and at Station 10 it is conifer forest, though the present cover is chiefly *Quercus chrysolepis* as the result of fire. The cover at Station 9 is chiefly chaparral, but scattered clumps of oaks and an occasional small conifer indicate that the chaparral might be a stage in succession to one of these more mesic forms. Also, the short duration of favorable soil moistures at Station 1 is undoubtedly important in producing the coastal sagebrush climax of this particular location.

SUMMARY CONCERNING THE ENVIRONMENTAL CONDITIONS

Polygonal graphing (Hutchinson, 1936, 1940) of the variables of the environmental factor complex permits the presentation of the maximum and minimum values of any of the factors as a unit. A standard scale is constructed in the following manner. Each factor is represented as units on a radius, the minimum value for positive factors which increase growth with increased numerical value, being placed one-fifth of the distance from the center of the circle to its circumference, which represents the maximum value. A suitable scale is then constructed between these two points. For negative factors which reduce growth with increased numerical value, the position of the maximum and minimum values are reversed, so that the minima lie on the circumference of the circle. The maxima and minima of the factor complexes to be compared are then placed on their respective radii, and are connected by lines. While Hutchinson used points midway between the maxima and minima to form a polygon approaching the optimum for the particular range of climatic factors, mean values have been substituted here, as it was felt that the actual means would give a truer picture of the factor complex than would measured points which give only the mid-points of the range. In most cases, the means approximate the median positions.

In a comparison of factor complexes occurring in climates as divergent as hydrophytic forest and desert, the degree of symmetry of the polygons is an expression of the balance of the factor complex. However, the symmetry exhibited by the polygons for the ten stations employed in this investigation, which comprises Figures 11A and B, is the result of the use of maximum and minimum values in the construction of the standard scale which were obtained in a small area where only difference in altitude and slope exposure cause variation in the factor complex.

Figures 11A and B, and Table 8 which gives the maximum, minimum, and mean numerical values used in their construction, indicate marked similarity in the polygons for all ten stations. The obvious conclusion is that the types of vegetative cover occurring in the area, which include coastal sage, chaparral, broad-sclerophyll woodland, and conifer forest, are produced by relatively small differences in the climatic complex. As it is inconceivable that the slight difference in soil temperature could have any pronounced effect in

differentiating between types of vegetative cover, and as evaporation rates which are in part determined by air temperature, show the greatest uniformity of any of the conditions measured, the greater amounts of soil moisture available on north slopes and at higher elevations must be the chief factor in determining the vegetative climax.

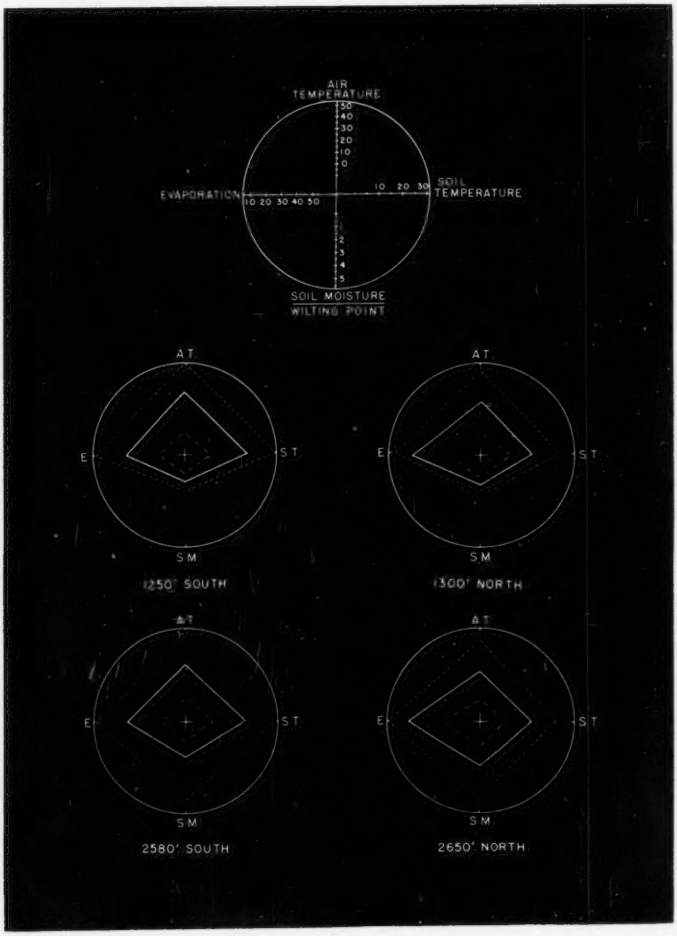

Fig. 11A.—Maximum, minimum, and mean environmental conditions at ten stations for the entire period of the investigation.

Growth

It is probable that growth of the shrub species comprising chaparral would occur at any time when moisture and temperature conditions were favorable. In the climate of southern California with its winter rains and hot, dry summers, these requirements are met yearly in late winter or early spring when temperatures rise, and continue into late spring or early summer, to be termin-

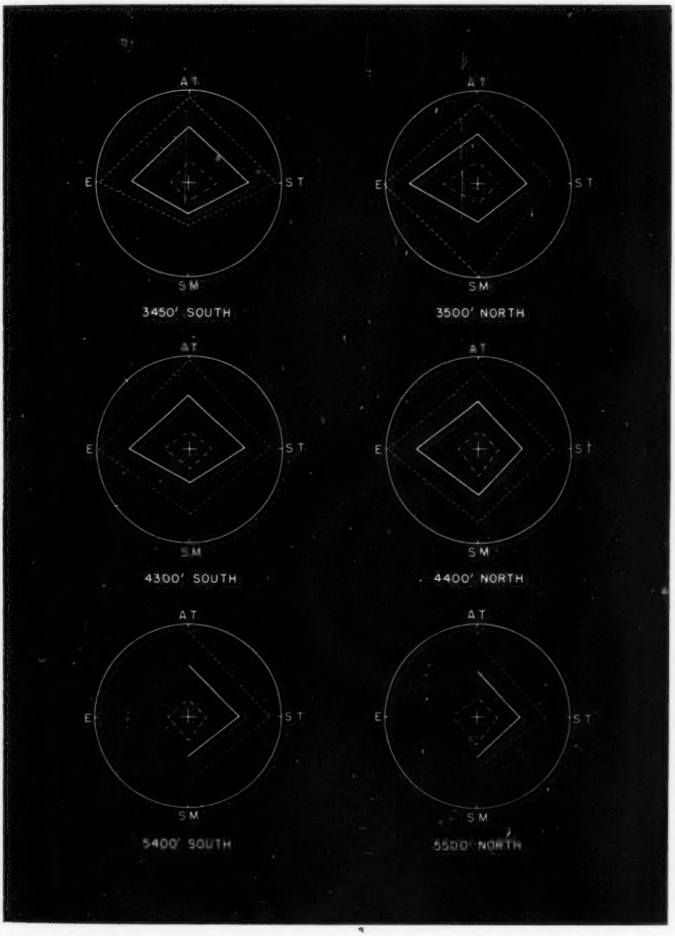

Fig. 11B.—Maximum, minimum, and mean environmental conditions at ten stations for the entire period of the investigation.

TABLE 8.—Average Environmental Conditions at 10 Stations for the Period of the Investigation.

Environmental Condition	Station	Maximum		Mean		Minimum	
		South	North	South	North	South	North
Air Temperature–Degrees C.	1500′	52.8	45.3	21.7	19.3	−6.4	−5.6
	2500′	51.1	43.3	23.2	17.4	−5.3	−6.1
	3500′	47.8	42.2	21.8	17.1	−6.9	−7.2
	4500′	50.0	40.0	20.3	16.2	−10.0	−9.4
	5500′	47.2	36.7	19.4	14.1	−10.0	−8.3
Soil Temperature–Degrees C.	1500′	31.1	25.6	19.3	14.3	3.3	5.6
	2500′	30.3	23.9	17.5	13.4	3.9	2.9
	3500′	28.6	23.7	17.4	13.2	4.4	1.1
	4500′	26.1	24.4	15.4	11.6	1.7	1.1
	5500′	26.8	21.1	14.0	10.9	0.6	1.1
Evaporation Rate–Cc. per day	1500′	49.1	42.9	27.0	20.1	8.3	5.0
	2500′	49.9	41.1	26.2	19.6	7.6	5.4
	3500′	53.2	42.3	27.7	20.2	6.7	3.7
	4500′	48.3	52.3	25.4	25.0	5.4	5.1
	5500′	51.6	49.3				
Soil Moisture divided by Wilting Point	1500′	1.5	2.0	0.8	1.0	0.3	0.4
	2500′	4.8	4.6	1.3	2.0	0.2	0.5
	3500′	2.0	5.7	1.0	1.6	0.2	0.3
	4500′	3.6	4.2	1.2	2.1	0.2	0.7
	5500′	3.8	2.7	1.8	1.9	0.5	0.8

ated by the reduction of soil moisture below the wilting point, or by high air temperatures and evaporation rates. If the advent of the first rains occurs before temperatures have fallen too low in autumn, a second and relatively unimportant growth period will occur. The dates on which these periods of favorable conditions obtain are variable as they reflect the variability of the climate.

In order to determine the occurrence of growth, the elongation of the stems of the dominant species at each station was measured. An attempt was made to mark selected twigs with waterproof ink, but when this procedure proved unsatisfactory, the following method was adopted. One branch on each of two plants was marked with a numbered tag. The length of the terminal twig was measured with calipers from the point of origin of the first lateral. This and the second lateral were then measured using the terminal twig as a reference. The second marked branch was measured in the same way. This procedure seemed as accurate and more convenient than marking with ink, particularly when rapid growth necessitating new markings was in progress. The

calipers were read to the nearest millimeter, no attempt being made to use the attached vernier. The six measuremnts were averaged and recorded as growth increment by the subtraction of the previous measurement. If the measurements were not at two-week intervals, they were converted to this unit mathematically.

The choice of species to be measured was based on two criteria. First, the plant must form an important part of the vegetative cover at that elevation, and second, it must occur at more than one station in order to permit comparison of the effect of elevation or of slope exposure on growth. Tables 2 and 3 show that only two important species were ruled out on either of these grounds, though the first criterion was relaxed in the case of *Arctostaphylos glandulosa* which was never a dominant species, but which had a wide altitudinal range.

Many difficulties were encountered in attempting to measure the growth in length of stems. The selected branches were frequently damaged by insects or other animals, or failed to develop. The terminal buds of several species such as *Arctostaphylos* and *Saliva* are protected by rosettes of leaves which open out successively as the bud develops. As it was impossible to determine the position of the bud, measurements had to be made to the tips of these leaves, so that at least some of the elongation recorded was due to the development of terminal leaves when growth was slow. The opening of the leaves might cause the stem to appear shorter than it was at the preceeding measurement. Five of the nine species measured either begin or end the season's growth with the development of terminal inflorescences, making it impossible to distinguish definitely between the cessation of purely vegetative growth and the onset of growth of inflorescences. With the species which begin growth by flowering, elongation due to development of inflorescences has been eliminated or indicated, but it has been included for species which flower at the end of the growing season. The great elongation of *Salvia apiana* is almost all due to the growth of the flowering stalk.

RELATION OF ENVIRONMENTAL CONDITIONS TO GROWTH

Growth rates in two-week intervals with the attendant environmental conditions measured in the course of the investigation are presented in Figures 12A-12E for the growing seasons of 1936, 1937, and 1938. The graphs for air and soil temperatures and evaporation have not been smoothed, and in consequence show the inherent variability exhibited by these factors in chaparral. However the points representing rates of growth in two-week intervals were connected by lines of best fit as it was felt that this method would present a picture closer to the actual result of growth in length of stems than would sharp peaks and depressions connected by straight lines. The time during which the soil moisture at depths of 15, 30, 60 and 100 centimeters was above the wilting point is shown by horizontal bars as in Figure 10, just below the graphs of growth rates. Though the measurement of soil moistures was not begun until May or June of 1936, the liberty was taken of extending the soil moisture bars from January of that year to the date at which the moisture fell below the wilting point to avoid the confusion which might result from the use of short horizontal bars. While the deepest soils may not have been saturated

until early February, it is improbable that the lateness of this heavy rain which insured saturation might have slowed the onset of active growth.

The greater fluctuation in the graphs of growth during 1938 as compared with the other two years is due to the interval employed in measuring the growth rate rather than to greater variation in growth itself in that year. From May until the end of the growing season, one week intervals were used, the increments being doubled to make the scale the same as that used in the two previous years. Plotting was done in this way because it was felt that expression of this real fluctuation was more important than a quantitative comparison of growth based on evidence insufficient to permit accurate conclusions. The use

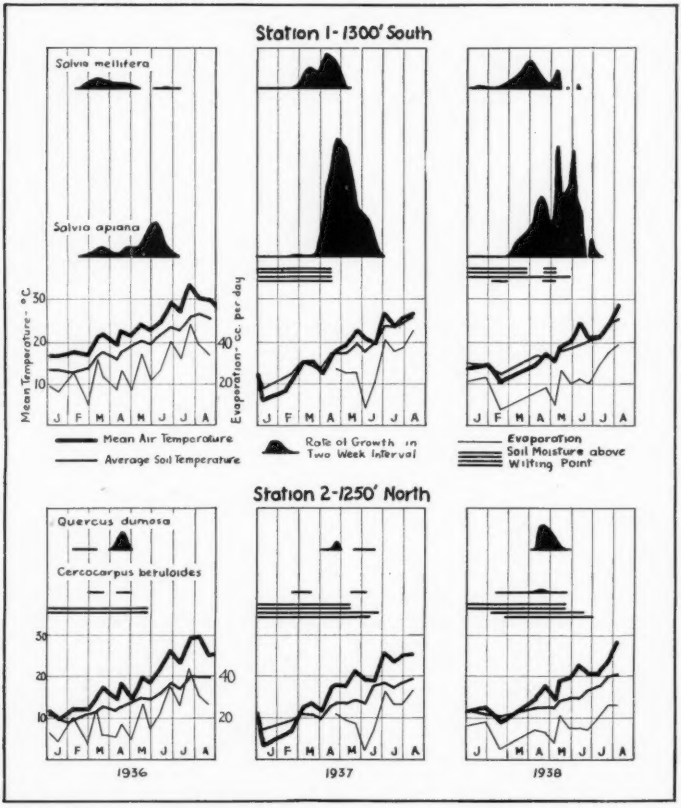

Fig. 12A.—Growth increments and mean air temperature, average soil temperature, evaporation rate, and period during which the soil moisture remained above the wilting point, during the growing seasons of 1936, 1937, and 1938.

of intervals of about a month in the graphing of evaporation rates during the first four months of the same year may have given an appearance of less variability in evaporation than actually occurred.

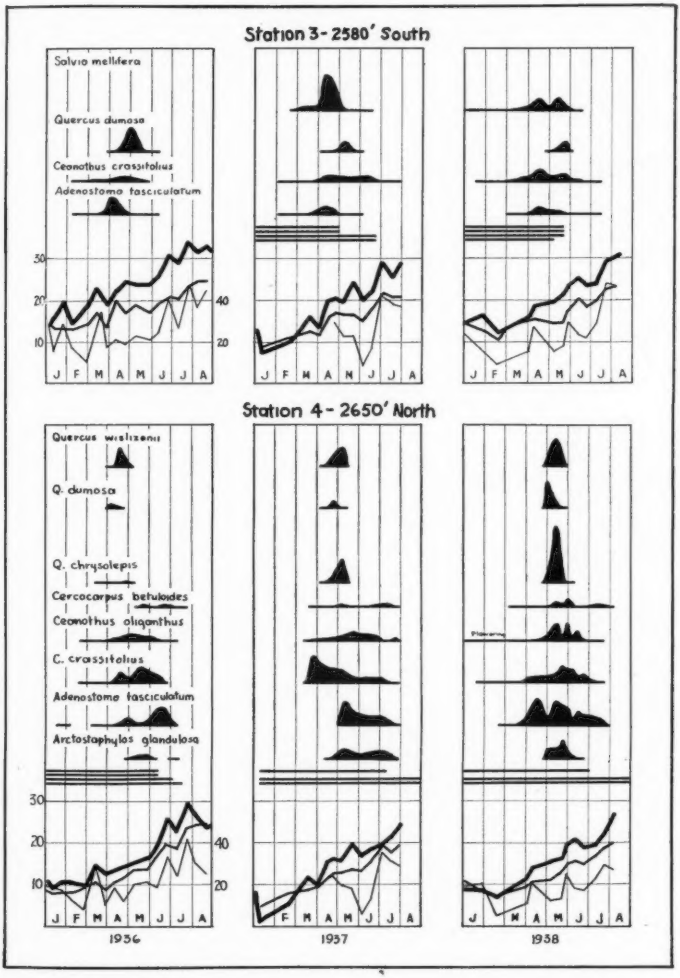

Fig. 12B.—Growth increments and mean air temperature, average soil temperature, evaporation rate, and period during which the soil moisutre remained above the wilting point, during the growing seasons of 1936, 1937, and 1938.

ENVIRONMENTAL CONDITIONS ON DATES OF INCEPTION OF GROWTH

Because it is difficult to make comparisons of environmental conditions on Figures 12A-12E, and because only mean values are given, Table 9 was constructed to give the average conditions and their ranges on the dates of inception of growth. An elongation of one centimeter in a two-week interval was chosen arbitrarily as "active" growth. When measurements of growth and of environmental conditions were made on alternate weeks as was sometimes done, the values recorded on the preceding week were used. In a few cases, values recorded after active growth began were used.

Table 9 indicates that maximum temperatures were higher on southerly slopes than on northerly slopes when growth began in all three years of the investigation. Average maximum temperatures exhibited considerable difference from year to year on these southerly slopes, while less than a degree separated

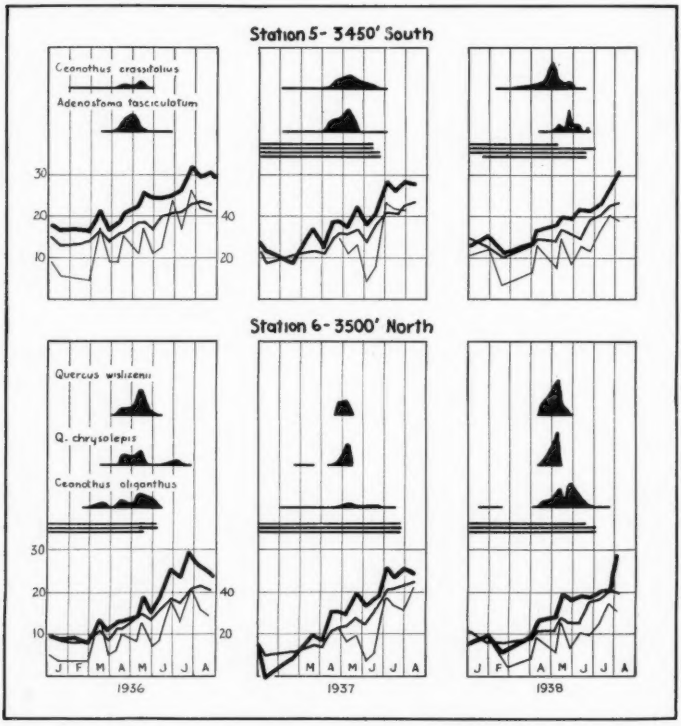

Fig. 12C.—Growth increments and mean air temperature, average soil temperature, evaporation rate, and period during which the soil moisture remained above the wilting point, during the growing seasons of 1936, 1937, and 1938.

the three yearly average maxima on northerly slopes. The range of temperatures through which growth began was also quite similar on these latter slopes, while it was variable on southerly slopes. This evidence would seem to indicate that maximum air temperature is not a critical factor in determining the onset of active growth in chaparral shrubs, though it seldom occurred with maxima below 23 degrees C. On the other hand, average minimum air temperatures were almost the same on both slopes during all three years. This similarity in minima is taken to mean that minimum air temperatures exert a controlling influence on the inception of growth. As growth occurred in only 9.7 per cent of the cases measured at temperatures below 0 degrees C., the generalization

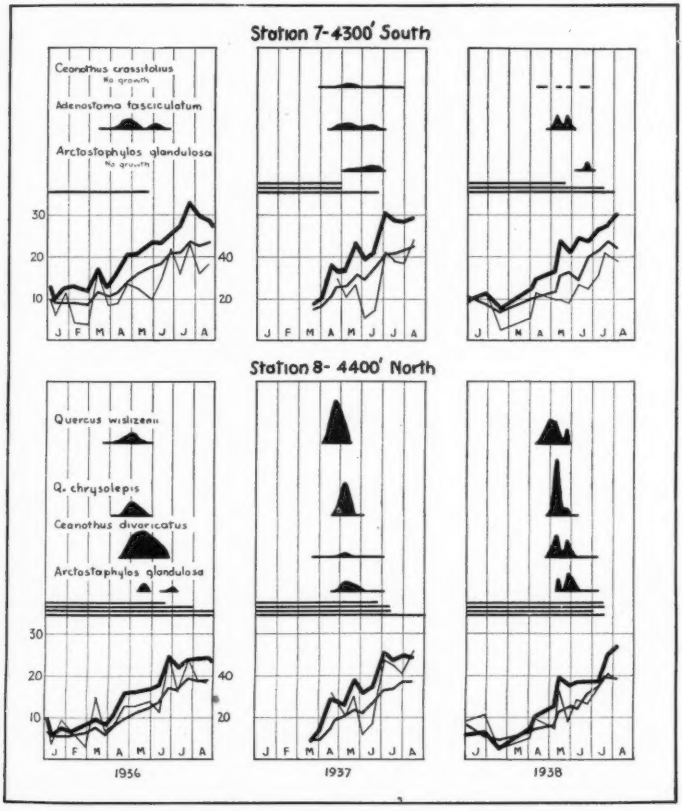

Fig. 12D.—Growth increments and mean air temperature, average soil temperature, evaporation rate, and period during which the soil moisture remained above the wilting point, during the growing seasons of 1936, 1937, and 1938.

may be made that temperatures must rise above freezing before active growth may commence.

As would be expected, altitude exerted an effect on the dates of inception of growth. Where these dates were compared in individual species occurring at different elevations on the same exposure, growth began first at lower elevations in 21 cases, first at higher elevations in 9 cases, and in the same interval

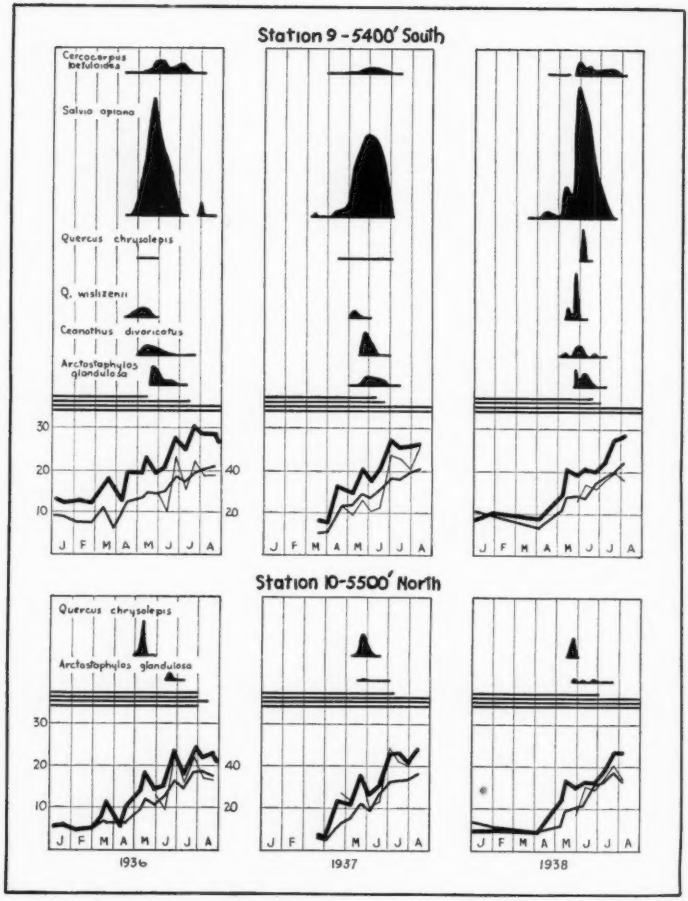

Fig. 12E.—Growth increments and mean air temperature, average soil temperature, evaporation rate, and period during which the soil moisture remained above the wilting point, during the growing seasons of 1936, 1937, and 1938.

in 13 cases. In a slight majority of the 9 cases in which growth occurred first at higher elevations, air and soil temperatures were found to be more favorable at the higher elevations at the time of inception of growth. When the dates of the start of growth were compared by elevations regardless of the species present, it was found that growth began first at lower elevations in 36 cases, and first at higher elevations in 10 cases, with 14 cases starting in the same interval. The effect of altitude on growth is, at least in part, the result of reduction in air temperatures.

In the few species which occurred on both north and south slopes at the same elevation, growth began first on northerly slopes in 9 cases, first on southerly exposures in 3 cases, and on both slopes in the same interval in 3 cases. As minimum temperatures appear to be the controlling air temperature factor, these temperatures for north and south slopes were compared. In the 9 cases where comparisons were possible, growth occurred first on northerly slopes in all but one case. In half of these instances, the air temperatures were lower on northerly exposures when growth began. While the number of cases is small, this evidence suggests that some factor such as diurnal temperature range or insolation might exert a retarding influence on the inception of active growth when minimum air temperatures become favorable, especially as soil temperatures were always lower on northerly slopes.

Because the variation in soil temperature at the four depths employed was usually within 2 degrees C. of the average and rarely more than 3 degrees from it, average soil temperatures were used in Table 9. The average of these soil temperaturees was always higher on southerly than on northerly slopes. However, the range of temperatures through which active growth began was smaller on northerly exposures. If the pattern of environmental conditions recorded in

TABLE 9.—Environmental Conditions on Dates of Inception of Growth.

Environmental Conditions		1936		1937		1938	
		South	North	South	North	South	North
Maximum Air Temperature–Degrees C.	Average	39.8	27.3	32.8	26.8	34.4	27.2
	Range	43.3–37.8	31.1–20.8	38.6–24.7	30.0–21.4	42.2–28.6	30.6–23.6
Mean Air Temperature–Degrees C.	Average	22.2	14.9	17.5	14.7	19.0	14.7
	Range	27.8–19.1	16.7–12.9	21.0–12.1	18.0–9.8	28.9–14.5	19.4–12.4
Minimum Air Temperature–Degrees C.	Average	4.6	2.2	2.1	2.3	3.8	1.9
	Range	12.2 – 0.0	5.6 – 1.4	6.1 – 2.3	6.7 – 1.9	8.7 – 2.2	9.4 – 1.1
Average Soil Temperature–Degrees C.	Average	16.0	11.3	14.3	11.5	15.0	10.8
	Range	19.9–11.4	13.8 – 9.7	17.7 – 9.5	13.6 – 7.4	19.9–10.8	14.5 – 8.1
Evaporation Rate–Cc. per day	Average	13.3	9.8	12.4	10.0	12.0	7.2
	Range	23.2 – 9.4	13.3 – 6.2	18.0 – 7.7	14.9 – 8.1	16.9 – 7.7	16.3 – 4.2
Soil Moisture Wilting Point	Average	1.8	.....	1.7	3.1	1.7	3.1
	Range	....	....	3.2 – 0.9	4.9 – 1.3	2.7 – 1.0	3.9 – 1.3

these three years is typical, it may be concluded that soil temperatures of 13 degrees C. on south slopes, and 9 degrees C. on north slopes are the minima at which active growth might be expected, as it occurred below these temperatures in only 10.9 per cent of the former and 7.5 per cent of the latter cases. The fact that growth began at lower soil temperatures on northerly exposures cannot be due to requirements of the plants, since 8 of the 11 species measured occurred on both slopes. As soil temperatures were always higher on southerly slopes on any given date at any pair of stations, and as growth usually began first on northerly exposures, it is apparent that soil temperatures in themselves were not the determining factor in the inception of active growth.

Every study of the evaporating power of the air in the habitat of chaparral has shown that its most obvious characteristic is great variability. As the white spherical cup atmometer measures the combined effects of air temperature, air movement, relative humidity, and to some extent, insolation, the evaporation rate is influenced by the fluctuation of four variables all of which in the southern California climate, are likely to vary together to increase or decrease it. During the growing season, periods of clear weather with higher air temperature, increased winds, lowered relative humidity, and unhindered insolation frequently alternate with periods of cloudiness or persistent advection fogs which reduce the effect of the four variables determining the evaporation rate. Because of this variability, it is impossible even to approximate the quantitative effect of evaporation on the inception of active growth.

The analysis of the evaporation rates when active growth began, given in Table 9, attests to the variability of the evaporating power of the air. The significance of evaporation in affecting growth would appear to lie in the 28 per cent lower average and the 23 per cent smaller range through which growth began on northerly exposures. As the evaporation rates summarize the effects of most of the factors which control the moisture requirements of the plant, it is probable that they hold the key to the retardation of the start of active growth on southerly slopes where temperatures would appear to favor earlier inception.

Environmental Conditions on Dates of Cessation of Growth

The picture presented by the measured environmental conditions at the end of the growing season differed little from that obtaining at its inception. The most notable feature would seem to be the small reduction in soil moisture during the growing season. Table 10 shows that the ratio of soil moisture to the wilting point which averaged 2.0 at the beginning of the growing season, was reduced to 1.6, and that growth stopped with the ratio lower than 1.0 in only 22.7 per cent of the cases. The small reduction may have been due in part to inability to sample soils actually in contact with actively absorbing roots, as capillary movement of water from moist to dry soils is very slow (Veihmeyer, 1927), or it may be due to the differences in evaporation rates occurring in the field and those used in determining wilting points in the laboratory (Brown, 1912; Caldwell, 1913). However, the fact that soil moistures

were much greater on northerly exposures, where evaporation rates, temperatures, and insolation were lower, would indicate that some factor or factors other than depletion of soil moisture brought on the end of the growing season.

During the growing season, maximum air temperatures had increased only 2.7 degrees C., and minimum air temperatures only 3.7 degrees C. Increases of this magnitude in themselves cannot be of importance to plants unless maxima have been reached, and as growth of the species measured occurred at various temperatures throughout a range of more than 20 degrees C., they certainly had not been approached in this instance. If air temperatures had any effect in bringing the growing season to an end, the effect must have been in the longer periods during which higher temperatures were maintained. These would not be shown in the readings of maximum-minimum thermometers over a two week interval, though they were indicated in the current temperatures recorded when the maximum-minimum thermometers were read. Soil temperatures increased 2.7 degrees C. on the average, and this small increase coupled with the fact that the average soil temperatures on northerly slopes had not risen as high as those on southerly exposures at the start of growth, would indicate that soil temperatures played no part in the growth of chaparral shrubs.

While evaporation rates increased only 21.7 per cent over the average rates which had obtained at the start of growth, the cause of cessation of growth would apparently lie in the increased effect of the factors producing the higher evaporation rates—increased air temperature and insolation, and reduced relative humidity. An examination of Figures 12A-12E indicates that growth was frequently reduced or terminated by a rise in air temperature and evaporation rates, while it was prolonged or increased by a reduction in the effect of these environmental factors. It seems reasonable to conclude that, for the years included in the investigation, growth of chaparral shrubs ceased in most cases

TABLE 10.—Environmental Conditions on Dates of Cessation of Growth.

Environmental Conditions		1936		1937		1938	
		South	North	South	North	South	North
Maximum Air Temperature–Degrees C.	Average	41.9	33.6	36.4	32.0	36.7	29.9
	Range	43.9–37.5	37.2–27.8	47.0–30.0	37.8–24.4	42.2–30.6	33.9–25.6
Mean Air Temperature–Degrees C.	Average	24.4	21.7	21.4	18.0	21.7	17.9
	Range	28.6–20.9	25.0–14.7	30.3–14.7	24.8–13.3	27.5–18.9	20.6–14.2
Minimum Air Temperature–Degrees C.	Average	7.0	8.0	6.4	5.5	6.7	6.1
	Range	13.3 – 0.6	13.3 – 0.0	13.5 – 2.8	14.4 – 1.7	15.0 – 3.3	11.1 – 2.2
Average Soil Temperature–Degrees C.	Average	18.1	15.0	17.1	13.7	17.2	13.9
	Range	21.1–14.7	19.3–10.6	23.8–11.8	19.3–10.1	20.4–12.5	18.4–10.2
Evaporation Rate–Cc. per day	Average	14.1	13.2	15.0	11.5	14.0	15.0
	Range	23.6 – 8.3	24.2 – 6.2	23.8 – 7.7	17.4 – 5.3	20.0 – 6.6	16.4 – 4.2
Soil Moisture Wilting Point	Average	1.1	1.4	1.3	2.3	1.2	2.3
	Range	2.3 – 0.6	2.6 – 0.8	1.8 – 0.6	3.6 – 1.2	1.9 – 0.5	5.9 – 0.9

because transpiration rates approached the rate of absorption by roots, while there was still sufficient moisture in the soil for growth at lower transpiration rates.

Summary

1. An investigation was made of the air temperature, soil temperature, evaporation rates, soil moisture, and the growth of the more common shrubs, in the chaparral of the San Gabriel Mountains of southern California, from December, 1935, to August, 1938. Stations were located on north and south slopes and at elevations from about 1500 to 5500 feet at roughly 1000 foot intervals.

2. Several types of vegetation occur in the area. On southerly slopes, coastal sage covers the basal portion, giving way at about 2000 feet elevation to chaparral which extends up to the highest point in the area, and contains three altitudinal zones. On northerly slopes, the chaparral extends from the foothills to about 4000 feet where it gives way to broad-sclerophyll woodland, which continues to the highest point in the area. However, there is evidence that the upper portion of this broad-sclerophyll belt might be a stage in succession after fire, the climax being conifer forest.

3. A 45-year rainfall average for Glendora, California, situated a few miles south of the area investigated shows that 75 per cent of the precipitation occurred in the four months, December through March. In the three years of the investigation, the rainfall was extremely variable, the total in 1937-1938 being almost double that of 1935-1936. Most of the precipitation occurred in a few heavy storms, as in 1935-1936 and in 1937-1938 when over 40 per cent of the year's total fell in single storms.

4. Evaporation, measured by white Livingston porous porcelain atmometer spheres, was found to be extremely variable from interval to interval. The effect of altitude on the evaporation rate was slight, but the effect of slope exposure was considerable, the average being 15 per cent greater on southerly than on northerly slopes.

5. Maximum, minimum, and mean temperatures were reduced with increased altitude, the reductions approaching the calculated amounts. Northerly slopes had much lower maxima and smaller temperature ranges than southerly slopes, while the minima were about the same. Highest temperatures occurred in August, and lowest temperatures in February.

6. Soil temperatures taken at depths of 15, 30, 60, and 100 centimeters, were reduced with altitude, the amount of reduction being somewhat less than that of air temperatures. Soil temperatures, were consistently lower on northerly than on southerly slopes, the ratio being about the same as in the case of air temperatures.

7. The average soil moistures dropped below the wilting point in June or July, and remained below until the winter rains. The deeper soils at a few stations remained above the wilting point throughout the summer. The greater

precipitation of 1936-1937 kept more soils above the wilting point in the summer of 1937 than in the preceding year.

8. Because the climatic conditions throughout the area vary but little, it is concluded that the types of vegetation occurring here are produced by relatively small climatic differences. It seems probable that the amount of available soil moisture is most important in producing the differences in vegetative cover.

9. Minimum air temperatures appear to be the controlling factor in determining the inception of growth in spring. The effect of altitude in retarding growth is apparently due to temperature reduction. Growth in species found on both north and south slopes, began first on north slopes in most cases, even when temperatures there were lower. It is suggested that the greater air temperature range, evaporation rates, or insolation on southerly slopes exerted a retarding effect on the inception of growth.

10. Environmental conditions at the end of the growing season differed only slightly from those at its inception. The cessation of growth was not caused by the reduction of soil moisture below the wilting point in most cases. It appears to be caused by factors which produce higher evaporation rates.

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Pugillus Astragalorum VII: A Revision of the Argophylli

R. C. Barneby

Introduction

The revision of *Astragalus* § *Argophylli* presented in this paper is based largely on my experience of the living plants. I have been fortunate in having been able to travel over most of the vast territories where the plants are native, and have collected and observed in their natural habitat all but three of the forty-odd species and varieties treated. This does not mean, of course, that the literature or the mass of pertinent material extant in herbaria have been neglected. At various times I have studied the collections at the Gray Herbarium, the New York Botanical Garden and Pomona College, which, since they contain the types and other specimens from which Gray, Rydberg and Marcus Jones formulated their concepts of *Astragalus*, are the most important in this country so far as the genus is concerned. Through the generosity of Miss Alice Eastwood I was able to borrow the large series of *Argophylli* from the California Academy of Sciences; Prof. C. Leo Hitchcock kindly loaned me the *Astragalus* collection from the herbarium of the University of Washington, and Prof. R. J. Davis that at the University of Idaho, Southern Branch. Shorter visits to the Rocky Mountain Herbarium at Laramie, the University of Minnesota and the Philadelphia Academy of Natural Sciences produced invaluable data on special problems. And from time to time Mr. Ripley and I have received gifts of material from Mr. J. T. Howell, Prof. Hitchcock and others, now in our private herbarium. To the curators of the herbaria consulted, and to all who have courteously aided and advanced the studies upon which this account of a difficult group of *Astragalus* is based, I express my grateful appreciation. To Mr. H. D. Ripley, through many years my constant companion in journeys through the Western States in search of *Astragali* and other plants, my debt will be apparent.

At first thought it may appear superfluous to prepare for publication what amounts to the third revision of the same group of plants to appear within twenty-five years. But anyone who has tried seriously to determine *Astragali* from the monographs of Jones or Rydberg will agree that this is not so. Jones was essentially a field-botanist, and as such he has my respectful admiration. I have repeatedly been impressed by the way in which experience of the growing plant has modified my own preconceived ideas to accord with his opinion of it. Unfortunately, however, Jones lacked the facility, or perhaps the patience, to express himself with logic or clarity; he had his own notions about nomenclature which are not shared by anyone today; and he stubbornly refused to admit the existence of species described by others which he himself had not

come across. His keys in the Revision of Astragalus are perhaps the worst that have ever been constructed. Rydberg, on the other hand, approached the genus from a technical and literary viewpoint, and his work betrays that occupational myopia which is commonly associated with the closet botanist. Clinging tenaciously to criteria which, in the withdrawn atmosphere of the herbarium, appeared significant, he was all too prone to recognize in ephemeral variations entities which have no existence in nature. His generic segregation in *Astragalus* (and elsewhere) has been almost universally ignored by systematists, so that his nomenclature is at best outmoded. My own aim has been to combine the diverse approaches of Jones and Rydberg. While I am only too aware of its shortcomings, and conscious of the numerous problems which, for lack of evidence or from their innate difficulty, have been left unsolved, I can only hope that this revision will mark some advance over that of my predecessors, to whom, in spite of a sometimes violent analysis of their work, I am so deeply indebted.

History of the Section

The earliest attempt to break away from the Candollean classification of *Astragalus* and *Phaca* as separate genera appeared in Gray's classic Revision of the North American Species in 1864. Here for the first time six species with strigose or sparsely villous legume were united in Ser. *Astragalus* § *Argophylli.* Only the last four of these, characterized by Gray as *Argophylli genuini,* belong to the section as now defined, and the first of these, *A. missouriensis* Nutt., must be regarded as typical. Immediately following the *Argophylli,* which Gray placed at the end of his series of true *Astragali,* we find at the head of Ser. *Phaca* a group of three species with floccose-woolly pods, the § *Eriocarpi.* Although the distinction between the species with densely woolly and merely pubescent pods is readily understandable, it is not clear to me why Gray placed one group in *Phaca* and the other among the true *Astragali,* since the pods are not more obviously bilocular in either. This disposition was maintained, however, through Watson's revised synopsis of the genus in the Appendix to the Botany of King's Report (1871), where *A. eriocarpus* was added to the Eriocarpi, and several species not properly belonging there were added to the Argophylli; and in Sheldon's inchoate Preliminary List (1894). In the latter the sections were renamed § *Famelicus* (*Argophylli*) and § *Lanocarpus* (*Eriocarpi*), and a number of (largely chimerical) species described and added, especially to the *Eriocarpi.* Into § *Famelicus* Sheldon moved *A. Chamaeleuce* which Gray had misplaced, and transferred *A. missouriensis, A. Shortianus* and others from that section to his own *Euastragalus* § *Sericophyllus* (aptly described by Jones, Rev. Astrag. 13, as a "hodge-podge"); it was no improvement.

In 1923 Jones' Revision of *Astragalus* was published, and Gray's two arbitrary groups, based on the vesture of the legume, were at last combined to form the § *Argophylli* as (with the exclusion of a few anomalous species) it is accepted here. In the meantime Rydberg, pursuing his lonely course of generic splitting, had erected in Small's Flora of the Southeastern States (1903) the genus *Xylophacos,* based on *A. Shortianus.* There followed, in

minor papers, a series of transfers to this genus, culminating in the Revision of *Xylophacos* in 1925, a treatment virtually copied into the North American Flora (1929). By this time the group, in which Gray had recognized nine species, Sheldon thirty and Jones twenty-two (and numerous varieties) had increased to an imposing total of forty-six. In the present account, which excludes one minor group (the *Iodanthi*) and two other species referred by Rydberg to *Xylophacos*, reduces eleven of his species entirely and subordinates eight to varietal status, (but recognizes three species lately discovered, one which Rydberg overlooked and several new varieties), in all twenty-seven specific and twelve varietal entities are maintained.

In Rydberg's *Xylophacos* the species are divided into several groups, the *Missourienses*, *Glareosi*, etc., characterized mainly by the type of pubescence and degree to which the legume is arcuate. These, like the early distinction between species with woolly or merely pubescent pods, seem to me unnecessary and often artificial, the passage between the groups being fully established in every case. Such minor divisions have therefore been abolished.

Definition of the Section

Although forming a tightly knit group of related species, the *Argophylli* do not lend themselves readily to definition in few or succinct terms. The shape and structure of the legume prevailing in the section is shared by several otherwise dissimilar species in the genus, and it is far from homomorphous in the *Argophylli* themselves. Rydberg described the legume as "coriaceous or woody, one-celled . . . the lower suture . . . never producing a false partition . . ."; but this fails to take into account the species or individual plants in which the valves of the pod are thinner than leathery, or as is often the case, narrowly infolded as a partial septum, and entirely excludes *A. leucolobus* with its definitely bilocular pod. Technically the latter species would be referred to Rydberg's genus *Hamosa*, but no one familiar with it can doubt its close affinity to *A. Purshii*, in which the legume lacks any trace of partition. In practice the pod is by no means an unfailing guide to relationships in *Astragalus*, although, as would be expected of a reproductive organ, it is frequently one of the best. It seems rather that all parts of the plant have to be considered, and a general congruence in facies, in the proportions of the flower, in stipules and even in apparently minor characters of herbage, root-system and habitat, is of equal weight as a clue to natural classification.

In my attempt to delimit the *Argophylli* to what appears to be a truly natural group, it has been found necessary to exclude a number of species admitted by Jones and Rydberg to their equivalent section or genus. These, together with some others which approach the *Argophylli* in various ways, are enumerated below, with a brief explanation of my reasons for excluding them. The general characters of the section will be found at the head of the taxonomic portion of the paper.

ASTRAGALUS CASEI Gray, Bot. Calif. 1:154. 1876. *Xylophacos Casei* (Gray) Rydb., Bull. Torr. Bot. Cl. 52:147. 1925. The calyx of *A. Casei* is

bibracteolate, and the pods are rigidly reflexed. These characters, combined with the plant's erect, wiry stems and bushy habit, and its narrow, remote leaflets, suggest only a distant relationship with the *Argophylli.* Jones, perhaps correctly, referred it to § *Pterocarpi.*

ASTRAGALUS CIBARIUS Sheld., Minn. Bot. Stud. 1:149. 1894. *Xylophacos cibarius* (Sheld.) Rydb., Bull. Torr. Bot. Cl. 40:48. 1913. *A. arietinus* Jones (1895). Including also *Xylophacos cuspidocarpus* (Sheld.) Rydb., an insignificant segregate.—The enlarged basal stipules, substipitate pod, flower structure and habit all recall the *Malaci.* The dorsal suture of the pod is often narrowly septiferous and thus approaches the otherwise very similar *A. ensiformis* Jones, in which the pod is wholly bilocular. Since the calyx also is often bibracteolate, *A. cibarius* seems to be quite far removed from the *Argophylli.*

ASTRAGALUS DESPERATUS Jones Zoë 2:243. 1891. *Batidophaca desperata* (Jones) Rydb., N. Amer. Fl. 24:319. 1929.—This species, referred to § *Argophylli* by Jones, and its relative *A. naturitensis* Pays., with their broad, scarious stipules, shortly campanulate calyx, short-clawed petals and chartaceous legumes, form a small and distinctive group of doubtful affinity, not closely resembling any member of the section under review.

ASTRAGALUS IODANTHUS Wats., Bot. King 70. 1871. *Xylophacos iodanthus* (Wats.) Rydb., Bull. Torr. Bot. Cl. 52:144. 1925.—The typical variety of *A. iodanthus* might conceivably be included in the *Argophylli,* but its relationship, through var. *diaphanoides,* to *A. pseudiodanthus* Barneby, wholly unlike any member of the section, weighs against its inclusion here (cf. Barneby, Leafl. West. Bot. 4:51. 1944). The calyx is often bibracteolate.

ASTRAGALUS MUSIMONUM Barneby, Proc. Calif. Acad. Sci. IV, 25:150. 1944.—This species should perhaps have been included, since it resembles the variable *A. amphioxys* in many ways, even to the type of pubescence (dolabriform, though erroneously described as basifixed). Its chief distinguishing character are the campanulate calyx and shortly clawed petals, the importance of which I may be over-emphasizing. It is interesting to remark that *A. missouriensis* has a similar "twin" in *A. accumbens* Wats., and the latter with *A. musimonum* form a small group as it were of *Argophylli* in a minor key. Their inclusion would weaken the *Argophylli* to the point where it would have to take in the whole of *Batidophaca* Rydb., as well as some miscellaneous species of other groups. Both *A. accumbens* and *A. musimonum* are rare species, localized at or near the range limit of their larger counterpart.

ASTRAGALUS PARRYI Gray, Amer. Jour. Sci. II, 33:410. 1862. *Xylophacos Parryi* (Gray) Rydb., Bull. Torr. Bot. Cl. 32:662. 1906. *Batidophaca Parryi* (Gray) Rydb., N. Amer. Fl. 24:318. 1929. *Astragalus Parryi* was an original element of Gray's *Argophylli,* and can be excluded only on the rather slim excuse that the calyx-tube is campanulate rather than cylindric, and the petals white, broader and with shorter claws, the flower thus having an aspect different from the rest of the section. It was placed by Jones in § *Malaci,* members of which it resembles very closely in facies, and in the broad lower stipules. It was removed from *Xylophacos* by Rydberg in his final monograph and its place in the genus has not been found as yet.

ASTRAGALUS PUNICEUS Osterh., Muhlenb. 1:140. 1906. *Xylophacos puniceus* (Osterh.) Rydb., Bull. Torr. Bot. Cl. 40:48. 1913. *Pisophaca punicea* (Osterh.) Rydb., N. Amer. Fl. 24:328. 1929. *Astragalus gracilentus* var. *exsertus* Jones, Rev. Astrag. 195. 1923.—Despite its long purple flower, copious villous pubescence and almost perfect *Xylophacos* pod, *A. puniceus* is clearly related to the *Flexuosi* (*Pisophaca* Rydb.), where referred by Jones and eventually, by Rydberg himself. The connate lower stipules and the loosely branched subterranean caudex are characteristic of its group.

ASTRAGALUS WEBBERI Gray, Bot. Calif. 1:154. 1876. *Xylophacos Webberi* (Gray) Rydb., Bull. Torr. Bot. Cl. 52:151. 1925.—The detached pod of *A. Webberi* would pass anywhere for that of a *Xylophacos*. However the (nearly always) bibracteolate calyx which becomes membranous and, as the legume matures, deciduous by circumscissile fission near the base, the whitish flower, the connate (lower) stipules and strongly caulescent stems distinguish the species very sharply from the rest of the section.

Phylogenetic Lines

The sequence of evolution in the *Argophylli* is not readily apparent from morphological evidence. So much alike are the species, that it is difficult to point to any one which may be considered primitive relative to the rest. Even assuming that the more complex has arisen from the more simple—a rash assumption, since evolution can doubtless work in both directions—one does not get very far on these lines. Nevertheless it may be presumed that the highly specialized pods of *A. Chamaeleuce* and *A. cymboides* are derived from the leathery state so common in the genus. Simple, basifixed hairs probably gave rise to the dolabriform. Caulescent habit, which is general in *Astragalus*, must have preceded the acaulescent state found in the xerophytic *A. Newberryi* and its allies. And the floccose-woolly vesture of the pod in *A. Purshii* and related species, a development unique to the section, must surely be a recent acquisition. If there is one species which combines all the more primitive states, and conforms to a basic pattern upon which the rest may be regarded as modifications, it is *A. argophyllus*. From *A. argophyllus* it is possible to trace, through contemporary species, several distinct and at times anastomosing lines of modification which may correspond (how closely one can only surmise) to the historical development of the section. From its var. *pephragmenoides*, at times quite difficult to separate from *A. Purshii* var. *glareosus*, it is but a step to *A. Purshii* itself, and thence to its close relatives *A. inflexus*, *A. utahensis* and others of the caulescent species with woolly pod. Through the stemless *A. uncialis*, not unlike *A. argophyllus* in other respects, a sequence leads directly to the acaulescent *A. Newberryi* and *A. eurekensis*, and thence, by a dichotomy, to *A. coccineus* and *A. musiniensis*. Through *A tephrodes* (forms of which Jones considered only varietally distinct from *argophyllus*) the passage to *A. iodopetalus* is not difficult; or through *A. panguicensis* (also at one time subordinated to *argophyllus*) to *A. castaneaeformis*, in which the hairs have become dolabriform. The group with dolabriform pubescence centering about *A. missouriensis* and *A. amphioxys* is somewhat

detached, but through *A. Chamaeleuce* a connection may exist with *A. Shortianus*. In the case of *A. Tidestromii*, which is very closely related to *A. amphioxys*, the evolution of the hairs from a basal to a median attachment is reversed.

Distribution and Origin

Though distributed throughout western North America, from the Mexican border to the limits of temperate Canada, and eastward from the Sierra-Cascade axis to the northern Plains and Texas, the Argophylli are essentially plants of middle altitudes in the Intermountain region, reaching their greatest development in the sagebrush and pinyon belt of the Great Basin. Of the thirty-nine species and varieties recognized in this paper, only two (*A. missouriensis* and *A. Shortianus*) are confined to the Atlantic slope of the continent; two (*A. tephrodes* and *A. amphioxys*) cross over from the Colorado River drainage into that of the Rio Grande, where they become, however, less common than to the west; a single species (the widely distributed *A. Purshii* var. *typicus*) extends from central Nevada north and east to British Columbia and Saskatchewan; and one (*A. inflexus*) barely penetrates from the Columbia Basin eastward to the headwaters of the Missouri. In contrast to this, sixteen species or varieties occur in Utah, fourteen in Nevada, ten each in transmontane California and Idaho, eight in northern Arizona (from the Mogollon Plateau northward), seven each in New Mexico, Colorado, Wyoming and Oregon, and only four each in Washington and Montana. Utah and Nevada together harbor twenty-four species, Nevada and California nineteen, and twenty-nine species and varieties, or nearly 75% of the section, occur in the combined territory of Utah, Nevada and transmontane California. Endemism figures follow a similar pattern, with five in Utah, four in California, two each in Nevada, northern Arizona and Idaho, and one in New Mexico. The Utah-Nevada-California region possesses fourteen endemics, or 35% of the section, and many more extend but a short distance beyond into the adjacent states.

The range of the individual species (*sensu lato*, here including their infraspecific satellites) varies in extent between the extremes of *A. Purshii*, extending from British Columbia to the Dakotas and southern California, or *A. missouriensis*, spanning twenty degrees of latitude along the Atlantic slope of the Rockies, and such narrow endemics as *A. funereus*, *A. uncialis* and *A. musiniensis*. The former are evidently plastic, with a climatic tolerance sufficiently wide to enable *A. Purshii*, in its various forms, to exist as well in the the canyons of the Mohave Desert as on the cold prairies of the northern Plains, and to climb to 11,000 feet along the easterly crest of the Sierra Nevada. The majority, however, are much more restricted, and for the most part are confined to a narrow climatic zone and environment, or to a distinct type of habitat. The essentially Sonoran *A. amphioxys*, and such inhabitants of the Sagebrush-Transition as *A. Newberryi*, have found ample room for expansion in the great continuous territories at their disposal, and these are naturally widespread. On the other hand *A. castaneaeformis*, *A. panguicensis* and *A. leucolobus* of the xeric yellow-pine forests are limited to the insular occurrence of their chosen association. Yet more narrowly confined are the ammophilous

species such as *A. callithrix* and *A. ophiogenes,* localized in small areas of partially stabilized dunes; *A. nudisiliquus* on the peculiar cobblestone bluffs along the Snake River; or the highly specialized *A. cymboides* and *A. musiniensis* on the bare clay knolls of the Navajo Sink.

The present-day center of dispersal of the *Argophylli* clearly lies in the Intermountain region. The fact that so many of the species are confined to habitats which have become available only in relatively recent geological times suggests that the section (apart from some remote, hypothetical ancestor) had its point of origin in the territory it now occupies, that it has found its greatest development there, and that the species have not immigrated from elsewhere. The *Argophylli* seem to form an element of the autochthonous vegetation of the Great Basin.

Hybridization

Jones' account of the *Argophylli* is replete with allusions to interspecific hybrids, but I have no conclusive evidence that such a thing occurs. In the field I have been especially on the alert for signs of hybridization, but although two or sometimes as many as four members of the section have been found in close association, I have never come across an individual which combined the characters of any two species, or which could not immediately be referred to a natural population of like plants. It is, of course, possible that hybridization occurs, but it must be quite exceptional. On examination Jones' supposed hybrids prove to belong either to a species which he had failed to recognize as such (and then were often collected far beyond the known range of one or sometimes of both hypothetical parents), or, in my opinion, to a species which Jones himself recognized, but whose inherent variability he would not admit.

While proof of active hybridization is lacking, it may be suspected that some *Astragalus* species have arisen in past times through the crossing of alien strains. *Astragalus Tidestromii,* discussed below, is a case in point. But to speculate in this direction is idle until something becomes known by experiment of the mechanics of speciation in the genus.

Criteria

a. *Life-form.*—A few species, notably *A. Newberryi, eurekensis, musiniensis* and *coccineus,* are invariably stemless, the mature plants consisting of several rosettes clustered on the summit of a taproot. In these, natives of regions where summer drought is prolonged, the petioles are stiff and persistent, forming with the marcescent stipules a protective thatch about the growing bud during the aestival resting period. The hard, thick crowns are not easily flattened in the press, and furnish an excellent diagnostic feature. In most of the *Argophylli,* however, the plants may be either strictly acaulescent or, under favorable conditions of soil and moisture, produce evident stems composed of a few congested internodes, these commonly persisting through several seasons as the branches of a suffrutescent caudex. In this group the petioles, though often remaining as flaccid, vestigial tatters about the base of the plant, do not form a stiff thatch round the terminal bud, and the crowns are readily flattened in drying. A third group of species, including *A. inflexus, utahensis* and *nudisili-*

quus, is normally caulescent, with extended, often zigzag stems forming loose mats 2—3 dm. in diameter; but in exposed positions or in years of light rainfall, individual plants may be as closely cespitose as the preceding. The general habit is therefore useful as a criterion only in some cases.

b. *Pubescence.*—With the exception of *A. tephrodes*, polymorphic in this respect, the quality, quantity and orientation of the hairs on the leaves and calyx are characteristic of a species, and provide criteria of the first value. In the majority the hairs are simple and basifixed, when they may be either straight, appressed and nearly parallel, or curly, spreading and tangled; smooth and lustrous or dull and minutely scabrous; filiform and flexible or thicker, stiffer and somewhat flattened. In a few species the hairs are attached near or much below the middle, being composed of an ascending and a shorter descending arm[1]. These dolabriform (malpighiaceous or pick-shaped—the *poils en navette* of DeCandolle) hairs are sometimes mixed with basifixed hairs, or (in *A. musiniensis*) the descending arm may be reduced to a mere knob or minute spur below the point of attachment. The color of the calyx-hairs is without diagnostic value in this group, dark and light hairs occurring in varying proportions in almost all the known species.

c. *Stipules.*—The stipules in the *Argophylli* are rather uniform, cauline or shortly adnate to the base of the petiole, and vary a good deal in length and shape within the compass of a species. In the *Purshii* group they are thin-membranous with a green midrib, and may be either deltoid or drawn out into long-acuminate tips. In most of the southern species the stipules are a trifle firmer in texture. Little of importance has emerged from comparison of these structures in different species; and the same may be said of the floral bracts, which, as in the genus as a whole, follow a similar pattern.

d. *Leaves.*—The number of leaflets to the well-developed, normal leaf of a species is variable within reasonably narrow limits, and has occasionally been found useful as a criterion for separating closely allied forms. It is a character which must be used with caution, however. Leaves with only three or five leaflets are characteristic of *A. uncialis* and *A. musiniensis*, but in *A. tephrodes* the leaflets vary in number from eleven to thirty-five. The shape of the leaflets is very variable. Even in those cases where obtuse (*A. utahensis*) or acute (*A. Purshii*, in part) leaflets may be said to be characteristic of their species as a whole, individual plants or some leaves on a plant often exhibit the opposite condition. Likewise the size of the leaflets is dependent largely on the state of vigor of the individual.

e. *Racemes.*—In most of the *Argophylli* the racemes are rather few-flowered, subcapitate in early anthesis and elongating but little in fruit. In a few a looser, many-flowered raceme may be almost characteristic, but in no case is it absolutely so, and little reliance can be placed on its length or on the number of flowers composing it.

f. *Flower.*—The relative proportions of the petals and calyx are much the same throughout the section, and offer few tangible peculiarities. In a very

1 Cf. Kearney, T. H. Leaf Hairs of Astragulus. Leafl. West. Bot. **4**:223-227, with plate. 1946.

few cases long or short calyx-teeth are a constant attribute of a species, but in nearly all this is a most treacherous character. As a rule the petals are strongly graduated, but less so in *A. leucolobus* and *A. tephrodes,* while the keel exceeds the wings in *A. funereus,* and the petals are subequal in *A. coccineus.* The absolute size of the corolla and calyx vary within rather definite limits, though the species are unlike in this respect, and in several an occasional plant will stand out as especially large- or small-flowered, or as having unusually broad banner, short keel, or narrow wings. Such variation is common throughout the genus, and must always be taken into consideration.

g. *Pod.*—Among the *Argophylli,* as in most *Astragali,* the structure of the pod is the surest and often the only infallible feature by which a species may be known. It must be realized, at the same time, that the pod is a most plastic organ, variable in length, outline and compression, and in the degree to which the dorsal suture is infolded as a partition. Thus in *A. missouriensis* var. *typicus* the pod is uniformly straight, but varies greatly in length; in *A. castaneaeformis* the ventral suture may be quite straight or strongly concave; while in *A. amphioxys,* where the ventral suture is normally concave, it may on occasion be straight throughout. Numerous similar ranges of variation are described below. In several species the beak (the sterile distal portion of the pod) varies between shortly deltoid to lanceolate or long-acuminate, and may be either little or much incurved. In *A. Shortianus* the pod is essentially 1-locular, but nearly always has a partial septum, and some tendency toward dorsal infolding of the valves has been observed in many of the species. Most reliable as a criterion in the legume is the texture of the valves, which varies little in a species, and considerable importance has been attached to this character in defining natural entities. It should be noticed that the measurements of thickness of the valves as recorded below have been taken from sections of dried material. In all the *Argophylli* the pod is more or less fleshy when first formed, and only assumes its characteristic texture when mature or dried, and this cannot be determined satisfactorily from young material.

Method of Citation

The citations of synonymy and literature are presented together, but arranged in such a way that an exact, nomenclatural synonym can be distinguished at a glance from a synonym of opinion, and both from so-called *sensu*-names. Thus all nominal combinations in any one paragraph are exact synonyms, being traceable back to the same basinym or based on the same type. The reference immediately following a name is the place of its publication, the succeeding ones referring to a correct use of the name in literature. Misidentifications are listed as sensu-names, e.g. "*A. glareosus* sensu Torr." in the synonymy of *A. tephrodes,* where Torrey misdetermined material of the latter, but had no intention of altering or adding to the nomenclature.

The exsiccata have been listed alphabetically by state and county, those of uncertain or unknown provenance being placed at the head of each category. In the case of widely distributed species not more than one specimen is cited from a county; exceptions have been made where the county covers a very large area (e.g. San Bernardino, Calif., or Nye, Nev.) or where the material

is diverse, or collections are of special historical interest. For the rarer and geographically restricted species, all or nearly all material seen by me is cited.

The following symbols have been employed to indicate the herbarium in which the specimens are preserved.

California Academy of Sciences, San Francisco (CAS)
Gray Herbarium, Cambridge (G)
New York Botanical Garden (NY)
Philadelphia Academy of Natural Sciences (P)
Pomona College, Claremont (PO)
University of Idaho, Southern Branch, Pocatello (Poc)
Herbarium of H. D. Ripley & R. C. Barneby (RB)
Rocky Mountain Herbarium, Laramie (RM)
University of Minnesota, Minneapolis (M)
University of Washington, Seattle (W)

Collections by Ripley & Barneby are all represented in our private herbarium, and the symbol (RB) has been used only where the specimen in question has reached us from other sources.

Taxonomy

ASTRAGALUS § ARGOPHYLLI (Gray) Jones

ASTRAGALUS § *Argophylli* (Gray) Jones, Rev. Astrag. 198. 1923, pro max. parte. *Astragalus* ser. *Astragalus* § *Argophylli* Gray, Proc. Amer. Acad. **6**:209. 1864, quoad "*Genuinos*"; Wats., Bot. King 435. 1871. *Astragalus* ser. *Euastragalus* § *Sericophyllus* Sheld., Minn. Bot. Stud. **1**:146. 1894, pro max. parte.

Astragalus ser. *Phaca* § *Eriocarpi* Gray, op. cit. 141. 1894; Wats., op. cit. 440. 1871. *Xylophacos* Rydb. ap. Small, Fl. S.E. U. S. 619, 1332. 1903; Bull. Torr. Bot. Cl. **52**:144. 1925, exclus. ser. *Iodanthis;* N. Amer. Fl. **24**:289. 1928; Amer. Jour. Bot. **15**:592. 1928. *Astragalus* subgen. *Xylophacos* (Rydb.) Tidestr., Cont. U. S. Nat. Herb. **25**:319. 1925; Tidestr. & Kitt., Fl. Ariz. & N. Mex. 190, 200. 1941.

Astragalus § *Argophylli* ser. "*Argophylli* proper," *Missourienses, Newberryenses, Coccinei* Jones, Rev. Astrag. 299–201, in clave. 1923.

Xylophacos ser. *Cyanei, Missourienses* (Jones), *Pygmaei, Eriocarpi, Glareosi, Coccinei* (Jones) Rydb., op. cit. 1925, 1929, 11 cc.

Perennial scentless herbs, often flowering the first year (and then, in dry seasons or habitats, becoming winter-annuals), cespitose and acaulescent or with evident, and then prostrate or diffuse, stems rising from the crown of a taproot, or from the divisions of a branched caudex; pubescence usually copious, composed either of simple (appressed or spreading) hairs or, wholly or in part, of dolabriform (malpighiaceous) hairs with one ascending and a shorter descending arm; stipules cauline or shortly adnate to the petiole; leaves imparipinnate, with 3—many leaflets articulate to the rachis; flowers pedicillate, spreading at anthesis, subcapitate to racemose; calyx deeply campanulate to long-cylindric, ebracteolate, ruptured by the turgescent ovary, persistent in fruit, the narrower tube longer than the teeth; petals relatively long and narrow, with slender claws, purple, sordid or ochroleucous, exceptionally white, deciduous; pod spreading, sessile, ovoid or oblong, commonly oblique and with a more or less well-defined sterile beak above the seminiferous body, laterally or dorsiventrally compressed (and then often sulcate along one or both sutures), wholly 1-locular or with the valves introverted dorsally as a narrow, usually incomplete, partition, the valves at first fleshy, becoming firmly chartaceous, coriaceous,

ligneous or spongy at maturity, either glabrous, strigose, hirsute or densely shaggy-villous and tomentose with matted hairs; dehiscence of the pod apical; ovules and seeds numerous, the latter oblong, notched at the hilum, compressed, smooth or minutely papillate, rarely mottled.

KEY TO THE SPECIES

1. Hairs of the herbage largely or entirely dolabriform (malpighiaceous), attached at or below the middle (2).
 2. Pod obliquely ovoid or lunate, arcuate, or if straight then dorsiventrally compressed, the dorsal or both sutures depressed (3).
  3. Leaflets 7 or more (in most of the leaves); petioles mostly deciduous, not forming a thatch on the rootcrown; stems evident, even when very short; stipules 1-3-nerved (4).
   4. Pod leathery in age, the valves 0.5 mm. thick or less, the epicarp and endocarp not separated by a thick layer of spongy tissue (5).
    5. Corolla pale, at most purple-tinged, and small, the keel exceptionally exceeding 12.5 mm. in length; pod 1-1.5 cm. long, obtuse and obcompressed at base; stems rising from a strong perennial root and branched, suffruticulose caudex. Plants of the Transition zone in northern Arizona and central Utah ..... 1. *A. castaneaeformis*
    5. Corolla bright purple, larger, the keel 13 mm. long or more; pod 2-5 cm. long, commonly acuminate and compressed at both ends or, if shorter and obcompressed at base, then the root annual or at least without a woody caudex (6).
     6. Pod readily deciduous; plants of the Sonoran zone (exceptionally higher), widespread from southern Nevada to Texas ..... 2. *A. amphioxys*
     6. Pod tardily deciduous; plants of the Transition zone in southern Colorado and adjacent Utah ..... 4b. *A. missouriensis* var. *amphibolus*
   4. Pod spongy in age, the epicarp and endocarp separated by a layer of cellular tissue at least 1 mm. thick. Plants of the basins of the Green and Grand rivers in southern Wyoming, Utah and western Colorado ..... 6. *A. Chamaeleuce*
  3. Leaflets 3 or 5, large, 1-3.5 cm. long; petioles persistent at base, forming a thatch on the enlarged rootcrown; stems obscure, concealed by the imbricated, several-nerved stipules. Pod cellular-spongy in age; plants of the Navajo Basin in Utah ..... 7. *A. musiniensis*
 2. Pod oblong, straight or nearly so, laterally compressed when dry, both sutures then becoming prominent and acute (7).
  7. Pod tardily deciduous or persistent, the valves becoming leathery in age, the epicarp not exfoliating; corolla bright purple; plants of the plains and eastern foothills of the Rocky Mountains, from Saskatchewan to Texas, the Rio Grande valley and southern Colorado ..... 4. *A. missouriensis*
  7. Pod promptly deciduous, the valves becoming cellular-spongy in age, the epicarp splitting along the ventral suture, separating from the endocarp and exfoliating as a pair of recurved, chartaceous wings; corolla commonly pale, more or less tinged with dull purple; plants of the Navajo Basin, Utah ..... 5. *A. cymboides*

1. Hairs all simple and basifixed (8).
 8. Valves of the pod glabrous, strigose or shortly pubescent with incumbent or curly hairs 1 mm. long or less, neither shaggy-villous nor long-hirsute nor matted-tomentose or, if somewhat so, then the herbage not arachnoid-villous nor matted-tomentose (9).
  9. Leaflets 3 or 5. Plants strictly acaulescent; corolla large, the keel 18-22 mm. long (10).
   10. Pod cellular-spongy, the valves at least 1.5 mm. long; stipules 6-8 mm. long, castaneous, 5-9-nerved; plants of the Navajo Basin, Utah ..... 7. *A. musiniensis*

10. Pod thinly coriaceous, the valves 0.3 mm. thick or less; stipules 3-4 mm. long, membranous, about 3-nerved; plants of central Nevada ..... 9. *A. uncialis*

9. Leaflets (except in a few early leaves) 7-numerous (11).

11. Pod laterally compressed at both ends, not mottled, 2.5-5 cm. long; leaflets mostly very obtuse. Plants of calcareous desert mountains of southern Nevada and adjacent California ..... 3. *A. Tidestromii*

11. Pod dorsiventrally compressed from the middle to base or, if somewhat laterally compressed at base (in *A. zionis*), then less than 2.5 cm. long, the valves mottled and the leaflets acute (12).

12. Pod commonly very large, 2.5-4.5 cm. long, the valves cellular-spongy and at least 1 mm. thick; plants of the Atlantic slope of the Rocky Mountains, from Wyoming south to the headwaters of the Rio Grande in northern New Mexico ..... 8. *A. Shortianus*

12. Pod commonly smaller, in any case the valves leathery or woody, less than 1 mm. thick; plants of the Great Basin, the Pacific slope of the Rocky Mountains and central New Mexico to western Texas (13).

13. Calyx appressed-sericeous or strigose, if villous the pod pubescent or the leaves equally pubescent on both faces (14).

14. Pod not mottled, not or scarcely sulcate ventrally (15).

15. Racemes nearly always surpassed by the leaves; leaflets equally sericeous on both faces, not bicolored; plants of the Great Basin, north of the Colorado River (16).

16. Flower relatively large, the calyx-tube 8-10 mm. long, the keel 13-19 mm. long; pod (with rare exceptions) ovoid, about twice as long as its greatest diameter; plants of western Colorado to central Nevada and northward ..... 10. *A. argophyllus*

16. Flower relatively small, the calyx-tube 6-7 mm. long, the keel 12 mm. long; pod lance-lunate in outline, about 3 times as long as its greatest diameter, gently arcuate throughout; corolla ochroleucous with purple-tipped keel; plants local in the mountains of southern Utah ..... 11. *A. panguicensis*

15. Racemes nearly always surpassing the leaves; leaflets often bicolored, glabrescent above; plants of Texas to southern Nevada, very rare north of the Colorado River ..... 12. *A. tephrodes*

14. Pod brightly mottled, ventrally sulcate towards the base. Plants of sandstone canyons in southern Utah and northern Arizona ..... 14. *A. zionis*

13. Calyx loosely hirsutulous with long hairs; herbage green, the leaflets glabrous or glabrescent above; pod wholly glabrous. Leaflets numerous, 17-27; plants of southern Colorado and northern New Mexico ..... 13. *A. iodopetalus*

8. Valves of the pod shaggy-villous, long-hirsute or matted-tomentose, if thinly so, or with hairs 1 mm. long or less, then the herbage arachnoid-villous or cottony-tomentose with very fine, contorted and matted hairs (17).

17. Corolla scarlet, the petals subequal, 3.5-4 cm. long; blades of the keel oblanceolate, straight, scarcely or not at all oblique. Plants of desert mountains of southern California ..... 15. *A. coccineus*

17. Corolla purple, purplish, pink, white or ochroleucous, less than 3 cm. long, the blades of the keel lunate, oblique, incurved (18).

18. Acaulescent, with hard, thick, multicipital crowns (except in seedling plants); petioles and peduncles stiffly persistent below as a thatch, commonly concealing the stipules; pubescence of the herbage appressed and silky, at least in youth, or, if spreading then composed mostly of stiff, arcuate and scarcely matted hairs, not fine and woolly; peduncles strigose or ascending-hirsute (19).

19. Peduncles and petioles partly hirsute with straightish, ascending hairs; corolla purple, but sometimes pale; pod obliquely ovoid, the valves usually quite concealed by the vesture of hirsute and tangled white hairs or, if thinly villous (in var. *Wardianus*) the valves chartaceous and much inflated ..... 16. *A. Newberryi*

19. Peduncles and petioles strictly strigose; corolla commonly ochroleucous or lead-colored; pod lance-ovoid, the valves thickly coriaceous, not concealed by the vesture of shining, at length tawny hairs. Plants of central Utah ..... 17. *A. eurekensis*

18. Caulescent, with apparent internodes or, of acaulescent, the crowns thin and readily flattened in drying; petioles and peduncles deciduous or but weakly persistent as soft, decaying tatters on the caudex or its branches; peduncles (except in *A. marianus*) softly villous or tomentose (20).

20. Pubescence of the stems, peduncles and herbage appressed-sericeous, composed largely or entirely of straight hairs; corolla pale, the tips of the keel, wings and sometimes the banner dull purple. Plants of central Utah to eastern Nevada ..... 18. *A. marianus*

20. Pubescence of the herbage arachnoid-villous, cottony-tomentose or, if composed largely or in part of coarse, straightish hairs, then these spreading on the peduncles and the corolla brilliant purple (21).

21. Wing-petals shorter than the keel. Leaflets obtuse; pods large, 2.5-4 cm. long, densely silky-tomentose; plants of Death Valley, California and adjacent Nevada ..... 19. *A. funereus*

21. Wing-petals manifestly surpassing the keel (22).

22. Pod shaggy-villous or hirsute with long hairs (2-6 mm. long, except in a form of the extra-Californian *A. Purshii* var. *glareosus*); petals strongly graduated, the keel much shorter than the banner (23).

23. Body of the pod (excluding the vesture) oblong-lanceolate, at least 3 times longer than broad, little arcuate, acuminate into a slender, fragile, subulate beak, the shape and surface of the thinly coriaceous valves entirely concealed by the shaggy vesture of silky, cream-colored hairs as long or nearly as long as the pod's greatest diameter; calyx-tube turgid, somewhat inflated. Leaflets broad, mostly obtuse, densely cottony-pannose; plants of northern and central Utah and the adjacent states ..... 20. *A. utahensis*

23. Body of the pod prevailingly obliquely ovoid, about twice as long as wide or, if relatively narrower, then with a stiff, usually incurved, deltoid beak; vesture of the valves much shorter than the pod's greatest diameter, or much thinner and not concealing either the shape or surface of the valves; calyx usually narrowly cylindric (except in *A. Purshii* var. *concinnus*) (24).

24. Vesture of the pod relatively sparse, villous or hirsute, not densely matted and concealing the surface of the valves (25).

25. Calyx-tubes 5-8 mm. long; pod strongly arcuate throughout, 8-13 mm. long and about 6 mm. in greatest diameter; plants of southern Idaho and central Nevada (26).

26. Banner 17-23 mm. long; herbage silvery with ascending, rather coarse, shining and scarcely tangled hairs; root slender, short-lived; plants of central Nevada .....21. *A. callithrix*

26. Banner 13-14 mm. long; herbage arachnoid-villous with very fine, tangled and cottony hairs; root strongly perennial; plants of the Snake River valley, Idaho .....22. *A. ophiogenes*

25. Calyx-tube 8-12 mm. long; pod at least 1.5 cm. long and 8 mm. in greatest diameter, straightish below and with incurved beak; plants of clay bluffs and sagebrush mesas in southeastern Oregon and adjacent Idaho (27).

27. Pod large and woody, the longitudinally striate valves 0.5-1 mm. thick; leaflets ovate, mostly obtuse; stems, when fully developed, strongly caulescent; plants of river-bluffs along the Snake and tributaries in the Sonoran zone..... .....23. *A. nudisiliquus*

27. Pod smaller, leathery, the reticulate valves not more than 0.3 mm. thick; leaflets elliptic, acute at both ends; stems subacaulescent, densely cespitose; plants of the Arid Transition zone .....25. *A. Purshii* var. *glareosus*

24. Vesture of the pod very dense, shaggy, completely hiding the surface of the valves or, if less so, then the calyx-teeth linear-setaceous and 4-7 mm. long (28).

28. Plants strongly caulescent (at maturity), the stems usually more than 1 dm. long, abruptly zigzag, rising from a very short, cespitose caudex or directly from the rootcrown; racemes loose in fruit, 3-9 cm. long; calyx-teeth commonly setaceous, 4-7 mm. long; corolla purple; pod strongly sulcate dorsally, the valves not or scarcely concealed by the relatively short and sparse vesture; upper leaves subsessile; plants of northeastern Oregon and adjacent Washington to Montana .....24. *A. inflexus*

28. Plants subacaulescent or, if with evident stems up to 1 dm. long, these not zigzag, or rising from a matted caudex, or the corolla ochroleucous, or the calyx-teeth much shorter; racemes in fruit 3 cm. long or less; leaves all equally petioled; plants widespread throughout western North America, north and west of the Colorado River .....25. *A. Purshii*

22. Pod shortly villous-tomentose, the vesture composed of very fine, tangled tomentum 1 mm. thick or less; petals tending to be subequal in length, not strongly graduated; plants of the interior mountains of California, from the southern Sierra Nevada to the Santa Rosa Mountains (29).

29. Corolla relatively large, the banner 16-18 mm. long; pod lance-oblong, deeply and narrowly sulcate dorsally, the valves somewhat intruded as a partition, the cross-section didymous; plants of Mt. San Antonio southward, on the desert slope ..... 26. *A. leucolobus*

29. Corolla relatively small, the banner 10-11 mm. long; pod obliquely ovoid, openly sulcate dorsally near the base, the valves not intruded; plants of the southern Sierra Nevada ..... 27. *A. subvestitus*

1. ASTRAGALUS CASTANEAEFORMIS Wats.

Astragalus castaneaeformis Wats., Proc. Amer. Acad. **20**:361. 1885; Sheld., Minn. Bot. Stud. **1**:129. 1894; Tidestr. & Kitt., Fl. Ariz. & N. Mex. 202. 1941; Kearn. & Peeb., Fl. Pl. Ariz. 479. 1942. *A. argophyllus* Nutt. var. *castanaeformis* [sic] Jones, Cont. W. Bot. **10**:62, Pl. 15. 1902; Rev. Astrag. 208, Pl. 47. 1923. *Xylophacos castaneaeformis* (Wats.) Rydb., Bull. Torr. Bot. Cl. **52**:155. 1925; N. Amer. Fl. **24**:297. 1929.

Acaulescent or with a loosely branched woody caudex and prostrate herbaceous stems up to 2 cm. long, the herbage greenish or thinly sericeous with slender, shining, rarely scaberulous hairs attached below the middle; stipules closely or loosely imbricated, ovate, acute, shortly adnate to the petiole, 4-7 mm. long, membranous and becoming castaneous, pubescent or glabrate; leaves 3-9 cm. long, the slender petiole about equalling the rachis and feebly persistent at base or wholly deciduous; leaflets (5) 7-13 (17), obovate to broadly oblanceolate or elliptic, rounded, abruptly acute or mucronulate at apex, 4-12 mm. long, equally pubescent on either face; racemes 4-9-flowered, 0.5-1.5 cm. long, scarcely elongating in fruit, the at length reclinate peduncles 1-5 cm. long, conspicuously shorter than the leaves; calyx strigose with dark or light hairs, the tube 5-7.5 (8) mm., the subulate teeth 1-2 mm. long; corolla ochroleucous or purple-tinged, the oblanceolate banner 12-15 (17) mm., the narrowly lunate wings 11-14 (15) mm., the abruptly arcuate keel 9-12.5 (14) mm. long; pod nearly hemispherical, obliquely ovoid or ovoid-lunate, very assymmetrical, 1-1.5 (very rarely to 2) cm. long, obtuse and obcompressed at base, abruptly acuminate into a short, compressed deltoid or deltoid-acuminate beak, the ventral suture prominent, straight or concavely arcuate, the dorsal strongly convex and neither sulcate nor intruded, the valves coriaceous but not more than 0.3 mm. thick when dry, reticulate but not rugose, castaneous and strigose or thinly silky; seeds black or dark brown, opaque, about 2 mm. long.

Type-Locality.—Near Williams Station, Arizona; collected by Mr. and Mrs. J. G. Lemmon in 1884.

Distribution.—Open stony flats or clearings in *Pinus ponderosa* forest, rarely on clay banks among junipers, alt. 6000 to 8000 ft., from the Mogollon and Kaibab plateaux of northern Arizona north to Sevier County, Utah.

Exsiccata.—ARIZONA. *Coconino Co.:* Williams, Lemmon & Lemmon in 1884 (G, type), Ripley & Barneby No. 5231. Flagstaff, MacDougal No. 199 (G, in part), No. 36 (PO), Ripley & Barneby No. 3112, Purpus in 1902 (PO), Eastwood in 1940 (CAS). Head of Oak Creek, Ripley & Barneby No. 4891. Mormon Lake, MacDougal No. 66 (G, NY, P, PO). 42 miles E. of El Tovar, Peebles & Smith No. 13336 (NY). Kaibab Forest, McKelvey No. 4388 (G). Kaibab Trail to Roaring

Springs, Eastwood & Howell No. 1105 (CAS). Grand Canyon, Toumey in 1892 (G). Jacob Lake, Ripley & Barneby No. 4918, Eastwood & Howell in 1933 (CAS). *Gila Co.:* northern Gila Co., fide Kearney & Peebles, l. c. UTAH: *Sevier Co.:* Ivie Creek, Ripley & Barneby No. 4749 (CAS).

Astragalus castaneaeformis differs from related species with dolabriform pubescence mainly by its small, relatively thin-walled pod. The flower is also prevailingly smaller and ochroleucous or at most purple-tinged, characters which distinguish it from all but *A. cymboides* of its immediate group. Jones regarded the species as no more than a variety of *A. argophyllus*, reduced forms of which it certainly approaches in general facies; but the attachment of the pubescence seems to be specifically diagnostic. The same criterion sets it off from *A. panguicensis*, which it otherwise closely resembles, both in habit and habitat. The pod is variable in outline and curvature, passing insensibly from the typical, hemispherical, very short-beaked form prevalent about the San Francisco Peaks to the lunate, less abruptly beaked form with concave ventral suture, which is commoner on the Kaibab.

The material from Sevier Co., Utah, a station far removed from the main area of distribution, may perhaps represent a distinct variety. The pubescence is somewhat coarser and scabrous, while the pods tend to be more leathery in texture and possibly, when fully developed, larger and more long-acuminate. Our specimens, evidently depauperate owing to the drought prevailing during the spring when they were collected, came from clay banks at the foot of a volcanic mesa, an unusual habitat for the species.

2. ASTRAGALUS AMPHIOXYS Gray

Winter-annual or perennial, subacaulescent or with a single erect, or several prostrate and cespitose, usually canescent stems up to 5 (15) cm. long, rising from a single taproot or exceptionally from the short divisions of a caudex; herbage densely silvery-canescent throughout with closely appressed, subparallel, straight, scabrous, dolabriform hairs, the vesture occasionally sparse and the whole plant greenish; stipules commonly discrete, deltoid-acute or long-acuminate, (2) 3-8 mm. long, membranous or early becoming so, strigose; leaves 3-10 (15) cm. long, the deciduous petiole shorter than the rachis; leaflets (3) 11-17 (19), or in the first year of growth often 3-7, elliptic to oblanceolate or obovate, acute or obtuse, 4-12 (20) mm. long, equally strigose (or rarely glabrate) on either face; peduncles stout, (1) 4-12 (20) cm. long, shorter than, equalling or sometimes far exceeding the leaves, at length reclinate; racemes subcapitately but loosely (2) 4-10 (12)-flowered, becoming 0.5-4 (6) cm. long in fruit; calyx strigose with all light or some (at times nearly all) dark hairs, the cylindric or rarely cylindro-campanulate tube (4) 5-8 (10) mm. long, the subulate teeth 1.5-3-5 mm. long; corolla bright pink-purple, exceptionally white; pod articulate with the receptacle and promptly deciduous, very variable in length and outline, (1.5) 2-4 (5) cm. long, 5-10 mm. in greatest diameter, normally 1) crescentic in outline, gently arched through ¼ to nearly a complete circle, laterally compressed and acute or long-acuminate at both ends, obcompressed at the middle, or 2) similar, but straight or nearly so, or 3) obcompressed throughout, or 4) when short, obtuse and dorsiventrally compressed at base, acuminate and laterally compressed at apex, but in any

case the ventral suture acute throughout (rarely depressed), the dorsal prominent, often sinuous, commonly depressed at the middle of the pod and lying in a double groove, the valves at first fleshy, becoming stiffly leathery, woody or somewhat spongy in age, reticulate or longitudinally striate, often alveolate-rugose on the obtuse, transversely dilated angles, sometimes mottled but commonly stramineous or castaneous, thinly strigose, the dorsal suture rarely inflexed as a partial and obscure partition 1 mm. or less deep, the cross-section at the middle varying according to the degree of obcompression from transversely oblong to ovate or cordate; seeds numerous, dark brown, shining but often pitted, (1.5) 2-3 mm. long.

An exceedingly polymorphic species, *A. amphioxys* is composed of numerous minor races marked by independantly fluctuating characters. From the mass of material studied it has been found possible to extract only one reasonably stable variety, which may be separated by the following

KEY TO THE VARIETIES OF A. AMPHIOXYS

Banner 13-23 mm. long, less than twice the length of the calyx-tube and teeth, the blade narrowly obovate or elliptic in the upper half; claws of the keel not or scarcely exserted; widespread from western Texas to southe.n Utah and Nevada ..... var. *typicus*

Banner 22-28 mm. long, more than twice the length of the calyx-tube and teeth, the blade broadly obovate in the upper half; claws of the keel evidently exserted; southwestern Colorado and southern Utah .....var. *vespertinus*

2a. var. typicus, nom. nov.

Astragalus amphioxys Gray var. *typicus* Barneby, nom. nov. *A. amphioxys* Gray, Proc. Amer. Acad. **13**:366. 1878; Coult., Cont. U. S. Nat. Herb. **2**:84. 1891; Sheld., Minn. Bot. Stud. **1**:147. 1894; Woot. & Standl., Cont. U. S. Nat. Herb. **19**:365. 1915; Jones, Rev. Astrag. 214, Pl. 50, 51. 1923; Tidestr., Cont. U. S. Nat. Herb. **25**:328. 1925; Tidestr. & Kitt., Fl. Ariz. & N. Mex. 201. 1941, exclus. syn. ult.; Kearn. & Peeb., Fl. Pl. Ariz. 478. 1942, inclus. var. *Xylophacos amphioxys* (Gray) Rydb., Bull. Torr. Bot. Cl. **32**:66. 1906; op. cit. **52**:148. 1925; Fl. Rocky Mts. 504. 1917; N. Amer. Fl. **24**:294. 1929.

A. Shortianus var. ? *minor* Gray, Proc. Amer. Acad. **6**:211. 1864, pro max. parte.

A. crescenticarpus Sheld., Minn. Bot. Stud. **1**:148. 1894. *A. selenaeus* Greene, Erythea **3**:76. 1895.

A. amphioxys x *Layneae* Jones, Rev. Astrag. 215. 1923, quoad pl. cit., vix descr. *Xylophacos melanocalyx* Rydb., Bull. Torr. Bot. Cl. **52**:149. 1925; N. Amer. Fl. **24**:294. 1929. *A. Marcusjonesii* Munz, Leafl. West. Bot. **3**:50. 1941, quoad typ. cit., non descr. nec. specim cit. *A. Tidestromii* (Rydb.) Clokey, Madroño **6**:214. 1942, pro parte, quoad syn.

Xylophacos aragalloides Rydb., Bull. Torr. Bot. Cl. **34**:48. 1907; op. cit. **52**:150. 1925; N. Amer. Fl. **24**:294. 1929.

X. brachylobus Rydb., Bull. Torr. Bot. Cl. **52**:154. 1925, pro parte, quoad typ. et specim. plur. cit.; N. Amer. Fl. **24**:297. 1929; non *A. Shortianus* var. *brachylobus* Gray, nec *A. brachylobus* DC. *A. curtilobus* Tidestr., Proc. Biol. Soc. Wash. **48**:40. 1935, saltem quoad nom. *A. curtilobus* Tidestr., op. cit. **50**:20. 1937; Kearn. & Peeb., Fl. Pl. Ariz. 479. 1942.

Astragalus cyaneus sensu Wats., Amer. Nat. **9**:270. 1875; Torr., Bot. Mex. Bound. Surv. 56. 1859; non Gray.

A. missouriensis sensu Rothrock, Bot. Wheeler's Exped. 95. 1878, pro parte; non Nutt.

Calyx-tube (4) 5-8 (10) mm. long; banner (13) 15-21 mm. long, elliptic or narrowly obovate in the upper half, less than twice as long as the calyx; wings (11) 14-18 mm., keel (10.5) 13-17 (21) mm. long, their claws not exserted; pod highly variable, as described for the species.

Type-Locality.—Doña Ana, New Mexico; collected by George Thurber.[2]

Distribution.—Valleys, plains and hillsides, on dunes or in other light, porous soils in the Sonoran zone, from western Texas (?and adjacent Chihuahua) up the Rio Grande to northern New Mexico, across northern Arizona to southern Utah and Nevada.

Exsiccata (*selecta*).—ARIZONA. Northern Arizona, Palmer No. 102, in 877 (G, type of *X. brachylobus*, NY). *Apache Co.:* Chinle Creek, Cutler No. 4641 (G, NY). W. of Carrizo, Peebles 13585 (NY). *Coconino Co.:* Moencoppa, Jones in 1890 (NY, PO). Tuba City, Peebles & Parker No. 14634 (G, PO). Grand Canyon, Eastwood No. 6046 (CAS). *Mohave Co.:* Peach Springs, Lemmon No. 3322 (G), Ripley & Barneby No. 5215. Chemihuevis Mts., Jones in 1903 (PO, type of *A. amphioxys* x *Layneae*). Pagumpa, Jones in 1894 (PO). Mesquite to Littlefield, Kearney & Peebles No. 13192 (CAS). *Navajo Co.:* Winslow, Wooton No. 16 in 1892 (M, cotype of *A. crescenticarpus*). Holbrook, Ripley & Barneby No. 5245, Zuck in 1896 (NY). NEVADA. *Clark Co.:* Glendale, Ripley & Barneby No. 3345 (CAS). Las Vegas, Jones in 1905 (PO), Goodding No. 2283 (NY), Ripley & Barneby No. 4294 (CAS). Charleston Mts., at Rocky Gap Spring, No. 3373. Mica Mine near Rioville, Jones No. 5072d (PO). *Lincoln Co.:* Muddy River, Goodding No. 2223 (G, M). Pahranagat Mts., Ripley & Barneby No. 4404. NEW MEXICO. *Bernalillo Co.:* Albuquerque, Kammerer No. 37 (NY). *Doña Ana Co.:* Doña Ana, Thurber No. 295 (G, type of *A. amphioxys*, NY). *McKinley Co.:* Zuni, Matthews in 1883 (G). *Sandoval Co.:* San Ysidro, Ripley & Barneby No. 2399. *San Juan Co.:* Farmington, Diehl in 1884 (PO). *Santa Fe Co.:* Santa Fe, Fendler No. 149 (G). TEXAS. *El Paso Co.:* El Paso, Mex. Bound. Surv. No. 255 (NY), Pringle No. 201 (P), Vasey in 1881 (M, type of *A. crescenticarpus*, G, NY). UTAH. *Emery Co.:* San Rafael Swell, Jones in 1914 (PO), Ripley & Barneby No. 4718. 25 miles S. of Green River, C. L. Porter No. 1774 (W). *Garfield Co.:* Canyon above Tropic, Jones No. 5312j (PO). *San Juan Co.:* SW. of Mexican Hat, Holmgren No. 3250 (W). Bluff, Ripley & Barneby No. 4384. *Sevier Co.:* Belknap, Stokes in 1900 (PO). *Washington Co.:* Southern Utah (probably near St. George), Palmer No. 101 in 1877 (G, NY), Parry No. 46 (G, NY, P), No. 49 (G, NY, P), St. George, Jones No. 1633 (NY, type of *X. aragalloides*, G, P, PO), No. 5110k (PO, wrongly annotated by Jones "type of *A. zionis*"). Copper Mine, W. of St. George, Jones No. 5009 (PO, type of *X. melanocalyx*). Pine Valley, Eastwood & Howell No. 1211 (CAS, G, PO). Ox Valley, N. of Central, Ripley & Barneby No. 4954.

The earliest collections of *A. amphioxys* to be seen by Gray were referred by him (in herb.) to *A. cyaneus*, and later to *A. Shortianus* var ? *minor*, where the species was first characterized, though still partly confused with *A. missouriensis*. Subsequently Gray segregated the *amphioxys* elements from this ambiguous variety, and the species came to be based on specimens, not precisely cited, collected by "Thurber, Parry, Palmer, etc." and a reference to *A. cyaneus* of Watson, Amer. Nat., 1. c. In his discussion of the type of *A. amphioxys* Rydberg chose Thurber No. 295, from Doña Ana, New Mexico, as representative, Thurber being the first collector cited in the original descrip-

2 The Mexican Boundary Survey labels are often inaccurate (cf. Standl., Cont. U. S. Nat. Herb. **13**:146. 1910), and the plant in question may well have been collected in western Texas.

tion. Since this gathering is in flower only, it would have been preferable to take one of Parry's numbers (No. 46 or 49), referred by Watson to *A. cyaneus,* but these were excluded by Rydberg on the ground that they were not conspecific, but belonged to his *Xylophacos aragalloides.* Although I am able to see in the latter no more than an insignificant form of *A. amphioxys,* and regard all of Gray's material as belonging here, I am content to follow Rydberg's choice of lectotype (cf. Rydb., Bull. Torr. Bot. Cl. 52:148.).

Astragalus crescenticarpus (for which Green substituted the more harmonious but illegitimate *A. selenaeus*) was based on two collections cited as "on sandy plains north of sulphur springs, New Mexico, June, 1883, by G. R. Vasey, and near Winslow, Arizona, June, 1892, by Prof. E. O. Wooton." In the herbarium of the University of Minnesota there are two specimens annotated by Sheldon as *A. crescenticarpus,* the Wooton gathering as specified in the diagnosis, and a second, from El Paso, Texas, collected by Vasey in 1881. This last is marked "Type specimen" in Sheldon's hand, and, in spite of the unexplained discrepancy between the published data and the label (received by Sheldon from S. B. Parish), it seems best to accept it as such. Both sheets represent quite typical *A. amphioxys,* a species which Sheldon misunderstood; material so named by him belongs chiefly to *A. tephrodes.*

As accepted here, *A. amphioxys* is a variable species, evidently very closely related to *A. missouriensis,* and in its early state, before the legume has formed, most difficult to distinguish from it. In the area where their ranges overlap in southwestern Colorado, a race occurs which is quite intermediate between the two, even in the characters of the pod (cf. *A. missouriensis* var. *amphibolus*). For the most part, and over an immense area of the Southwest, *A. amphioxys* is sharply marked, and there can be no question as to its specific status. To the west, and especially in southern Utah and Nevada where it is abundant, it assumes many different guises, some of which have been recognized as species, varieties or hybrids. These are enumerated below, with remarks on their synonymy and occurence, but none seem quite worth formal recognition.

a) The typical form, from the Rio Grande Valley and here and there through the range of the species: densely white-pubescent, even as to the calyx; pods tending to be rather thinly coriaceous and inconspicuously rugose on the angles of the valves, sometimes mottled, about 2.5 cm. long and 5 mm. high; leaflets small, elliptic and acutish.

b) Often stouter, with a tendency to black hairs on the calyx, a more coriaceous pod very strongly rugose on the angles of the valves and 3-5 cm. long, up to 8 mm. high; leaflets often larger and greener. This is the common form in northwest Arizona and adjacent Utah and Nevada, recognized as *Xylophacos melanocalyx* Rydb., *A. amphioxys* var. *melanocalyx* Tidestr., *A. amphioxys* x *Layneae* Jones in part, and often confused with the related *A Tidestromii;* it has some claim to recognition as a variety. However we have forms from the west combining white calyx and stout legume, while from El Paso, Texas, come specimens with slender legume combined with nigrescent calyx. Many intergradient individuals exist, in no way correlated with distribution. It appears to be a low-altitude, low-humidity ecotype.

c) A robust green plant, sparsely strigose and strongly caulescent. To this belong Wetherill's gathering from Kayenta, Ariz., referred by Rydberg to *X. melanocalyx*, and Ripley & Barneby No. 4304 from Shivwitz Village, Washington Co., Utah, the latter found in the shelter of tall sagebrush. It is a shade form.

d) *Xylophacos aragalloides* Rydb. This was originally characterized by its narrow, acute leaflets, and by its long bracts and calyx-teeth. The latter were described as 3-4 mm. long and (N. Amer. Fl. **24**:290, in clave) "more than half as long as the tube;" however, in part of the type-collection (PO) they are but 1.5 mm. long, scarcely one quarter the length of the tube, and the species rests simply on the narrow leaflets and the finer, more silky (though still dolabriform) pubescence. Manifestly an ecotype growing on dunes, and even there highly unstable as to width of leaflets, length of bracts, etc. (cf. Ripley & Barneby No. 3345).

e) A rather striking form, seen only from "gumbo" flats, about alkaline springs or seeps, near Las Vegas, Nevada, where collected by Jones, Goodding and Ripley & Barneby. Pubescence of very short hairs but copious, the whole plant and young legume white; root exceptionally stout and woody. The Goodding collection was referred by Rydberg with some doubt to *Xylophacos Tidestromii;* but the hairs are dolabriform.

f) *Xylophacos brachylobus* Rydb., *A. curtilobus* Tidestr., excluding the basinym. The type chosen as representative of *X. brachylobus,* No. 102 of Palmer's 1877 collection, is a specimen of *A. amphioxys* with short calyx-teeth and lacking fruit, but Rydberg's concept was a mixture (cf. *A. tephrodes* var. *brachylobus,* below). It is not the original *A. Shortianus* var. *brachylobus* Gray, except in so far as the name was transferred from that variety. *Astragalus curtilobus* (a substitute, the trivial *brachylobus* being preoccupied in *Astragalus*) has been applied to an annual or winter-annual form of *A. amphioxys* with short pods very abruptly acute at base rather than long-acuminate. The extreme form, with legume but 1.5 cm. long (e.g. Peebles & Smith 13374), is striking, but from Peach Springs, Arizona, I have specimens showing the occurrence of short and normal pods in the same population, while every intermediate condition is known.

g) A distinct and peculiar form from the Grand Canyon, known only from two specimens (Grand View Trail, Eastwood No. 5711, 5712, CAS): stems petioles and peduncles very slender; stipules broad, short but conspicuous, castaneous; leaflets 5-9, thin, green and sparingly strigose; corolla large, the keel 17-19 mm. long; pod narrowly oblong to linear- oblong, acute or acuminate-attenuate at either end, 2-3 cm. long. The material is insufficient for full analysis, but suggests a distinct variety.

2b. var. VESPERTINUS (Sheld.) Jones

Astragalus amphioxys Gray var. *vespertinus* (Sheld.) Jones, Rev. Astrag. 215, Pl. 51. 1923. *A. vespertinus* Sheld., Minn. Bot. Stud. **1**:150. 1894; Graham, Ann. Carn. Mus. **26**:25. 1937; Tidestr. & Kitt., Fl. Ariz. & N. Mex. 202. 1941; Kearn. & Peeb., Fl. Pl. Ariz. 479. 1942. *Xylophacos vespertinus* (Sheld.) Rydb., Bull. Torr. Bot. Cl. **32**:662. 1906; op. cit. **52**:229. 1925, exclus. syn. et specim. cit. plur.; Fl. Rocky Mts. 505. 1917, exclus. syn.; N. Amer. Fl. **24**:299. 1929, exclus. syn.

Calyx-tube (7) 8-10 mm., the teeth 1-3 mm. long; banner 22-28 mm. long, more than twice the length of the calyx, its blade very broadly obovate in the upper half, commonly about 8 mm. wide near apex; wings 21-26 mm., the keel 19-24 mm. long, their claws exserted; pod about 3 cm. long and 7 mm. broad at the greatest diameter, oblong and abruptly acute at both ends, obcompressed except near base and apex, or sometimes nearly throughout, gently arcuate through about 1/4 circle or less, with both sutures prominent but more or less depressed, at least toward the middle of the pod, the valves fleshy, becoming leathery or somewhat spongy-cellular (but less than 0.5 mm. thick), mottled or not, strigose.

Type-Locality.—Grand Junction, Colorado; collected by Alice Eastwood in 1892.

Distribution.—Clay mesas and sandy valleys in the drainage of the Green, Grand and upper Colorado rivers in western Colorado and southern Utah.

Exsiccata.—COLORADO. *Garfield Co.:* 10 miles below Newcastle, Jones in 1892 (PO). *Mesa Co.:* Grand Junction, Eastwood No. 6109 (M, type, NY, PO, photo.), No. 5086 (CAS), Jones No. 5476d (PO), Crandall in 1898 (NY). UTAH. *Emery Co.:* Green River, Jones in 1891, in 1895, in 1915 (PO), Tidestrom No. 1225 (NY). *Garfield Co.:* Cottrell's Ranch, Henry Mts., Jones 5658r (PO). *Grand Co.:* Cisco, Jones in 1889 (PO). *Kane Co.:* Kanab, Mrs. Thompson (NY), Eastwood & Howell No. 9308 (CAS). Kanab Creek, Ripley & Barneby No. 4341 (CAS). Hidden Lake near Glendale, Jones No. 25430 (CAS, PO).

In Jones' opinion (Rev. Astrag. 215) the var. *vespertinus* was "a form hardly deserving varietal rank," and it is accepted here with some caution. The pod has been described by Rydberg as straight, but this is true of only part of the type and of an exceptional individual here and there; as a rule, even in the type-locality, the pod is moderately arched its entire length, and is distinguished by no constant feature not observed somewhere in var. *typicus*. The greater size of the petals (not an absolute criterion), and particularly their length relative to the calyx, the ample banner with its broadly obovate limb and the exserted claws of the wings and keel combine to give the flower of var. *vespertinus* a characteristic aspect, and it is on this, rather than any peculiarity of the fruit, that the variety is maintained. The exactly typical phase of var. *vespertinus* is known only from the lower reaches of the Green and Grand rivers; in this the pod is unmottled and inclined to be oblong and to become somewhat cellular-spongy when mature, thus appearing to intergrade with *A. cymboides* endemic to the Navajo Basin (cf. Jones, Cont. W. Bot. **15**:13. 1923). In the neighborhod of Kanab, Utah, the variety is represented by a race with brightly mottled leathery pod, of exactly the shape and texture prevailing in var. *typicus*.

Rydberg's interpretation of *A. vespertinus*, based on the assumption that the straightish pod furnished by a part of the type-collection was characteristic of a natural entity, led him far astray. In his account of *Xylophacos* (Bull. Torr. Bot. Cl. **52**:229) he referred to *X. vespertinus* a whole series of specimens of *A. missouriensis*, with which the type of *A. vespertinus* has little in common. On the other hand good *vespertinus* with arcuate pod is cited (op. cit., passim) as belonging to *X. cyaneus* (Grand Junction, Crandall), *X. Shortianus* (do.), and *X. brachylobus* (Kanab, Mrs. Thompson). His reduc-

tion to *X. vespertinus* of *A. panguicensis* Jones seems quite incomprehensible in the circumstances, since Jones' description and figure of the latter both portray an arched pod. It is clear that *X. vespertinus* of Rydberg lacks basis in reality.

3. ASTRAGALUS TIDESTROMII (Rydb.) Clokey

Astragalus Tidestromii (Rydb). Clokey, Madroño **6**:214. 1942, exclus. syn. plur. *Xylophacos Tidestromii* Rydb., Bull. Torr. Bot. Cl. **52**:155. 1925; N. Amer. Fl. **24**:297. 1929.

A. amphioxys x *Layneae* Jones, Rev. Astrag. 215. 1923, quoad descr., non specim. cit.

A. Marcusjonesii Munz, Leafl. West. Bot. **3**:50. 1941, quoad specim. calif. cit., exclus. syn. et typ.

A. amphioxys sensu Tidestr. & Kitt., Fl. Ariz. & N. Mex. 201. 1941, pro parte, e syn.; non Gray.

Subacaulescent, or the prostrate stems elongating and becoming up to 7 cm. long, these clustered on the summit of a stout vertical taproot and, like the herbage, tomentose- or villous-canescent with a vesture of fine, basifixed, loosely ascending, curly hairs; stipules closely imbricated to discrete, deltoid, acute or acuminate, 3-7 mm. long, membranous, heavily pubescent without; leaves 4-15 cm. long, the rather stout petioles (1) 3-6.5 cm. long, persistent at base on the older plants; leaflets (7) 11-19, thick, suborbicular, ovate, obovate or broadly elliptic, subtruncate, obtuse or rarely subacute, 4-13 mm. long; racemes loosely 5-13 flowered, becoming 2.5-6 cm. long in fruit, on stout, at length reclinate peduncles (3) 6-12 cm. long, equalling or shortly surpassing the leaves; calyx shortly villous-tomentose, predominantly with dark hairs, the tube 5-6 (8) mm., the subulate teeth 1-2 mm. long; corolla sordid, the wings and keel-tip purple, the rest purple-tinged; banner 13-16 mm., the wings 12.5-15 mm., the keel 11-14 mm. long, the blades of the latter gently arcuate through about 100° to the rounded apex; pods obliquely lanceolate in outline, long-acuminate at apex and shortly so or cuneate at base, compressed at either extremity but elsewhere obcompressed, arcuate through half to somewhat more than a complete circle, 2-5-5 cm. long, at the middle 8-15 mm. broad and 4-6 mm. high, both sutures prominent throughout, the dorsal depressed towards the middle of the pod and lying in an open double groove, the valves fleshy and becoming very stiffly leathery, about 0.5 mm. thick, reticulate and strongly rugose on the angles, canescent when young, at length strigose and stramineous; seeds about 2.5 mm. long.

Type-Locality.—Wilson's Ranch, Charleston Mts., Nevada; collected by Ivar Tidestrom in 1919.

Distribution.—Gravelly outwash fans and sandy playas on calcareous substrata, commonly associated with Larrea, from extreme southern Nevada westward across the Mohave Desert to the San Bernardino Mts., California.

Exsiccata.—CALIFORNIA. *San Bernardino Co.:* Cushenbury Canyon, San Bernardino Mts., Ripley & Barneby No. 2853. Kessler Springs, Munz No. 13750 (PO). Mountain Pass, Clark Mts., Ripley & Barneby No. 3366. Valley Wells, No. 6389. Ivanpah Mts., Jaeger in 1940 (PO). NEVADA. *Clark Co.:* Wilson's Ranch, Tidestrom No. 9661 (NY, fragments, isotype). Good Springs, Jones in 1905 (PO). Kyle Canyon, Charleston Mts., Clokey No. 7995 (NY). Indian Springs, Jones in 1906 (PO).

Las Vegas, Goodding No. 2283 (M). Desert Range, Ripley & Barneby No. 3330. Sheep Mt. near Jean, No. 3324 (CAS). Erie, Tidestrom No. 8889 (G).

From the original diagnosis it is clear that Jones had *A. Tidestromii* in mind when he described *A. amphioxys* x *Layneae*. But having succinctly pointed out the characters of the hybrid, and indicated as its range "where the two species overlap in Nevada," he unfortunately cited two specimens from Arizona and Utah which are not conspecific, but merely represent the form of *A. amphioxys* with black-strigose calyx prevalent in the region. These later formed part (though not the actual type) of Rydberg's segregate *Xylophacos melanocalyx*, and are distinguished from *A. Tidestromii* by their dolabriform pubescence. The early confusion between these related species has been perpetuated in recent years by Munz and Clokey, the former citing under the name *A. Marcusjonesii* (a substitute for *melanocalyx*, unavailable in *Astragalus*) material of *A. Tidestromii*, the latter reducing both *A. Marcusjonesii* and its nomenclatural parent *X. melanocalyx* to *A. Tidestromii*.

This species is exceptionally interesting in that it combines with astonishing precision, as noted by Jones, the flower and pubescence of *A. Layneae* Greene with the legume of *A. amphioxys*, and it is impossible not to wonder whether it originated from a fertile hybrid between the two. At present, at any rate, there can be no question that it behaves as a fixed and marked species, and occupies territory from which either one or both of the hypothetical parents is absent. From all forms of *A. amphioxys*, the only species with which fruiting material could be confused, *A. Tidestromii* differs not only in its loose, basifixed pubescence, but also in the smaller, dull purple corolla. The Goodding collection from Las Vegas, Nevada, referred here by Rydberg (1925, l. c.), is a form of *A. amphioxys* discussed above.

4. ASTRAGALUS MISSOURIENSIS Nutt.

Subacaulescent or more commonly with several prostrate, herbaceous stems (1) 3-10 (15) cm. long radiating from the crown of a taproot or the divisions of a shortly branched, suffruticulose caudex, forming depressed, tufted plants; stems and herbage strigose throughout with appressed, straightish, dolabriform hairs, commonly densely so and canescent, rarely greenish; stipules broadly deltoid to deltoid-acuminate, 3-8 mm. long, submembranous but green at first, discrete or the lower loosely imbricated, these sometimes obscurely connate at base; leaves ascending, (2) 4-10 cm. long, the almost always deciduous petioles usually a little shorter than the rachis; leaflets (5) 11-17 (21), elliptic or narrowly obovate, commonly acute or mucronate, but often somewhat broader and obtuse, (3) 5-12 (16) mm. long; peduncles stiff and rather stout, equalling or often exceeding the leaf; racemes subcapitately 5-12 flowered, becoming 1-3 cm. long in fruit; calyx strigose, usually with some dark hairs, the cylindric tube 5-9 mm., the subulate teeth 1.5-4.5 long; corolla bright purple, drying bluish or pale, exceptionally white; banner (14.5) 16-23 mm., the wings (13) 16-21 mm., the keel (11.5) 13-19 (20) mm. long; pod leathery or somewhat woody, variable in shape, strigose or glabrescent in age, reticulate, unmottled, at length turning almost black.

With its immense latitudinal range, extending from the thirty-first to the fiftieth parallel, *A. missouriensis* displays considerable variation in stature, and

in size of calyx, corolla and legume, but there seems to be but one race sufficiently marked to deserve recognition as a variety. It may be distinguished by the following key.

KEY TO THE VARIETIES OF A. MISSOURIENSIS

Pod oblong or elliptic in outline, straight or nearly so, scarcely or not at all oblique ..... var. *typicus*

Pod lance-ovoid or lunate, strongly arcuate and conspicuously oblique, the ventral suture straight or somewhat concave, the dorsal convex ..... var. *amphibolus*

4a. var. typicus, nom. nov.

Astragalus missouriensis Nutt. var. *typicus* Barneby, nom. nov. *A. missouriensis* Nutt., Gen. N. Amer. Pl. **2**:99. 1818; DC., Prod. **2**:287. 1825; G. Don, Gen. Hist. **2**:258. 1832; T. & G., Fl. N. Amer. **1**:331. 1838, exclus. syn.; op. cit. 692. 1840; Gray, Pl. Fendl. 35. 1849; Proc. Amer. Acad. **6**:210. 1863; Port. & Coult., Syn. Fl. Colo. 26. 1874; Rothrock, Wheeler's Rep. 95. 1878, exclus. pl. ariz.; Wats., Bot. King 440. 1871; Coult., Cont. U. S. Nat. Herb. **2**:84. 1891; Rydb., Fl. Neb. **21**:49, Pl. X, fig. 58, 59. 1895; Cont. U. S. Nat. Herb. **3**:493. 1896; A. Nels., Bull. Wyo. Exper. Sta. **28**:97. 1896; Coult. & Nels., Man. 286. 1909; Woot. & Standl., Cont. U. S. Nat. Herb. **19**:364. 1915; Britt. & Br., Ill. Fl. Ed. II, **2**:383, fig. 2547. 1923; Jones, Rev. Astrag. 213, Pl. 50. 1923, exclus. syn. plur. in indice enumeratis; Tidestr. & Kitt., Fl. Ariz. & N. Mex. 202. 1941. *Tragacantha missouriensis* (Nutt.) O. Kze., Rev. Gen. 946. 1891. *Xylophacos missouriensis* (Nutt.) Rydb ap. Small, Fl. SE. U. S. 620, 1332. 1903; Fl. Rocky Mts. 505. 1917; Bull. Torr. Bot. Cl. **52**:229. 1925; N. Amer. Fl. **24**:299. 1929; Fl. Prair. Pl. 474. 1932.

A. melanocarpus Nutt., Fraser's Catal. 1. 1813, nom. nud.; Richards., Bot. Append., Franklin's Journ. 746 (in separate, p. 28). 1823, nomen; Hook., Fl. Bor.-Amer. **1**:150. 1831.

A. setosus Pursh ex Richards., l. c., in syn.

A. missouriensis Nutt. *b*) T. & G., Fl. N. Amer. **1**:331. 1838.

A. missouriensis Nutt. fma. *longipes* Gand., Bull. Soc. Bot. Fr. **48**:xv. 1902.

A. missouriensis Nutt. fma. *microphylla* Gand., l. c. 1902.

A. missouriensis Nutt. fma. *leucophaea* Gand., op. cit. xvi. 1902.

Pod oblong to oblong-elliptic, stright or nearly so, 17-25 mm. long, (4) 5-8 mm. in greatest diameter, obtuse at base, abruptly acute and terminating in a subulate, pungent beak 1.5-4 mm. long, subterete or very slightly obcompressed when fully formed, in drying becoming somewhat 4-angular, the straight or equally convex sutures then prominent and acute, the middle of the valves transversely dilated, obtusely angled and somewhat rugulose, the walls of the valves fleshy at first, becoming coriaceous or somewhat woody, 0.3 mm. thick or less, castaneous or at length black, rarely introflexed dorsally as a very narrow and inconspicuous partial septum; dehiscence complete or nearly so ventrally, the dorsal suture splitting only near the apex, but the epicarp fissuring along the whole line of the suture and exposing the endocarp.

Type-Locality.—On hills throughout Upper Louisiana; collected by Thomas Nuttall.

Distribution.—Plains, foothills and prairies, on bluffs or in dry soil, to the south mostly on limestone or gypsum, Saskatchewan and Alberta, south to western Texas, eastward to western Oklahoma, Kansas and the valley of the Minnesota River, westward through the foothills of the Rocky Mountains from

Montana to Colorado, the Rio Grande valley, and extending thence into the Pacific drainage along the San Juan River in southern Colorado and northern New Mexico.

Exsiccata (*selecta*).—STATE UNKNOWN. Sine *loc.*, Nuttall (NY, ex herb. Lambert, probable isotype). Rocky Mts., Nuttall (NY, annotated "*A. melanocarpus*" by Nuttall, probably *A. missouriensis* b) of T. & G.). Northwest America, Franklin Expedition (G, ex herb. Hook., as *A. melanocarpus*). Sine loc., Fremont in 1845 (NY). ALBERTA. Bow Valley, Moodie No. 815 (G, NY). Medicine Hat, Macoun No. 4204 (G, NY). COLORADO. Sine loc., Hall and Harbour No. 127 (G). *Archuleta Co.:* Arboles, Baker No. 417 (G, NY, PO). *Fremont Co.:* Cañon City, Brandegee in 1872 (P). *Huerfano Co.:* Turkey Creek, Rydberg & Vreeland No. 5972 (NY). *Larimer Co.:* Fort Collins, Crandall No. 150 (G), in 1898 (NY, isotype of *A. missouriensis* fma. *leucophaea*). *La Plata Co.:* Durango, Ripley & Barneby No. 5346 (CAS). *Las Animas Co.:* Trinidad, Florence Beckwith No. 97 (NY). *Lincoln Co.:* E. of Limon, Penland No. 1582 (CAS). *Pueblo Co.:* Pueblo, Rydberg & Vreeland No. 5973 (NY). *Weld Co.:* Evans, E. L. Johnston No. 635 (NY). *Yuma Co.:* Wray, Eggleston No. 15152 (NY). KANSAS. *Decatur Co.:* Oberlin, Smyth No. 271 (NY). *Ellis Co.:* Hays, Albertson No. 508 (CAS). *Mitchell Co.:* sine loc., Carleton in 1888 (G). *Osborne Co.:* Osborne City, Shear No. 12 (G). *Rooks Co.:* sine loc., A. S. Hitchcock No. 1016 (G, NY). MINNESOTA. *Big Stone Co.:* Ortonville, Moyer in 1898 (NY). *Yellow Medicine Co.:* Granite Falls, Moyer in 1910 (G, M). MONTANA. *Broadwater* Co.: 10 miles S. of Helena, Hitchcock & Muhlick No. 11801 (RB). *Custer Co.:* Miles City, Gunterman No. GX7 (W). *Dawson Co.:* Glendive, B. T. Butler No. 2007 (NY). *Fergus Co.:* E. of Lewistown, Ripley & Barneby No. 8215. *Gallatin Co.:* Bozeman Pass, Canby, Transcontinental Surv. No. 76 (G). *Lewis & Clark Co.:* Helena, Kelsey in 1891 (PO). *Meagher Co.:* NW. of White Sulphur Springs, Hitchcock & Muhlick No. 12197 (RB). *Park Co.:* Livingston, Scheuber No. 371 (NY). *Stillwater Co.:* Absarokee, Ripley & Barneby No. 8063. *Sweet Grass Co.:* Greycliff, March No. 8950 (G, NY). *Yellowstone Co.:* Custer, Blankinship in 1890 (G). NEBRASKA. *Cheyenne Co.:* Sidney, Diehl (PO). *Frontier Co.:* Curtis, Rydberg No. 73 (NY). *Kimball Co.:* Upper Lawrence Fork, Rydberg No. 73, in part (NY). *Knox Co.:* Fort Niobrara, Wilcox in 1888 (NY). *Sheridan Co.:* Hay Springs, MacDougal No. 40 (NY). NEW MEXICO. *Colfax Co.:* E. of Maxwell, Eggleston No. 20058 (NY). *Mora Co.:* Wagon Mound to Las Vegas, McKelvey No. 4908 (G). *Otero Co.:* Hueco Mts., Thurber No. 142 (G). Sacramento Mts., F. S. Earle No. 551 (NY). *San Juan Co.:* Aztec, Baker No. 418 (PO). *San Miguel Co.:* Pecos, Standley No. 5020 (NY). *Santa Fe Co.:* Santa Fe, Fendler No. 149 (G, NY), A. A. & E. G. Heller No. 3519 (NY). *Socorro Co.:* Ash Springs Canyon, San Andreas Mts., Wooton in 1913 (NY). *Taos Co.:* W. of Ranches of Taos, Ripley & Barneby No. 7551. *Union Co.:* Desmoines, Eggleston No. 20111 (NY). NORTH DAKOTA. *Benson Co.:* Minnewaukan, Lunell in 1907 (M, NY). *Billings Co.:* E. of Medora, Ripley & Barneby No. 8248. *Slope Co.:* Marmarth, Moyer No. 511 (M). *Ward Co.:* Minot, Lunell in 1909 (NY), No. 642 (M). OKLAHOMA. *Beaver Co.:* Knowles, G. W. Stevens No. 343 (G). *Cimarron Co.:* Kenton, No. 472 (G, NY). *Custer Co.:* Weatherford, Waterfall No. 447 (CAS, NY). *Ellis Co.:* Pack Saddle Bridge, Goodman No. 2597 (NY). *Harmon Co.:* E. of Gould, Ripley & Barneby No. 7492. *Harper Co.:* Buffalo, G. W. Stevens No. 303 (NY). *Texas Co.:* sine loc., Camp No. 388 (G, NY). *Woods Co.:* Cora, Camp No. 220 (G, NY). SASKATCHEWAN. sine loc., Bourgeau in 1858 (G, NY). Crane Lake, Macoun No. 4205 (G, M, NY). Moose Jaw, No. 12499 (PO). Saskatoon, Geol. Surv. Canad. No. 70489 (G). SOUTH DAKOTA *Butte Co.:* Owl Creek, N. of Belle Fourche, Eggleston No. 12527 (NY). *Custer Co.:* Hermosa, Rydberg No. 627 (NY). *Fall River Co.:* Hot Springs, No. 626 (NY). *Harding Co.:* Camp Crook, J. W. Moore No. 711 (M). *Jackson Co.:* Kadokah, E. J. Palmer No. 37007 (G). *Meade Co.:* Piedmont, Pratt in 1895 (G, M, isotypes of *A. missouriensis* fma. *longipes*). *Walworth Co.:* Glenham, Moyer in 1909 (M). TEXAS. *Brewster Co.:* Glass Mts., Warnock No. 57, 571 (G). *Briscoe Co.:* Floyd's Crossing, Demaree No. 7657 (G). *Culberson Co.:*

Guadalupe Canyon below Signal Peak, Ripley & Barneby No. 4206 (CAS). *Hardman Co.:* Kirkland, Cory No. 13327 (G). *Howard Co.:* Big Spring, E. J. Palmer No. 34004 (G). *Lynn Co.:* Between Tahoka and Lubbock, Small & Wherry No. 12158 (NY). *Lubbock Co.:* SE. of Lubbock, Demaree No. 7464 (G). *Nolan Co.:* Sweetwater, Reverchon No. 1275 (NY). *Oldham Co.:* W. of Adrian, Ripley & Barneby No. 7510a. WYOMING. since loc., Parry, NW. Wyo. Exped. No. 711 (G). *Albany Co.:* Laramie, A. Nelson No. 52 (G). *Crook Co.:* S. of Hulett, Ownbey No. 560 (W). *Johnson Co.:* Buffalo, Tweedy No. 3161 (NY). *Laramie Co.:* Pine Bluffs, A. Nelson No. 2898 (NY, PO). *Natrona Co.:* Casper, No. 9731 (NY). *Sheridan Co.:* Big Horn, Tweedy No. 2356 (NY). *Yellowstone National Park:* Livingstone Mt., E. W. Scheuber in 1902(M).

The typical variety of *A. missouriensis* is here understood to embrace a series of imperceptibly intergradient forms, differing in the size and shape of the leaflets, the density of the vesture, and in the length of the flower and legume. In general there is a southward progression from the form with relatively small corolla, short calyx-teeth and usually short pod prevalent on the northern Great Plains to a southern, calciphile or gypsophilous extreme in Oklahoma, Texas and New Mexico, marked by its large, showy flower, long calyx-tube and teeth, and often longer and stouter pod. These are connected, however, by innumerable individuals of intermediate dimensions, the distinctive characters are nowhere constantly associated, and the geographic segregation is by no means complete. Here and there as far north as Montana there occurs a plant with flowers as large and calyx-teeth nearly as long as the most extreme southern form, while the small-flowered plant, though rare, has been collected near the southern limit of the species in Oklahoma. None of the southern plants were admitted by Rydberg to *A. missouriensis*. Those with large flowers he mistook for *A. cyaneus* (*A. Shortianus* var. *cyaneus*), and approximately half the specimens cited by him (Bull. Torr. Bot. Cl. 52:154) as *Xylophacos cyaneus* belong here; they may be distinguished at first glance from the true *cyaneus* by their straight pod and dolabriform pubescence. On the other hand he referred the New Mexican material of *A. missouriensis*, which is mostly small-flowerd, to his chimerical *X. brachylobus*.

Jones (Rev. Astrag., Index) included in the synonymy of *A. missouriensis* a list of names which have nothing to do with the species: *A. missouriensis* var. *cuspidocarpus* (Sheld.) Jones (and its exact equivalent *A. thermalis* Greene) was utterly ambiguous in Jones' sense, and is ultimately based on a specimen of *A. cibarius* Sheld.; *A. Shortianus* var. *minor* is the nomenclatural parent of *A. amphioxys;* and *A. puniceus* Osterh., elsewhere accepted by Jones as a variety of *A. gracilentus* Gray, is a species of the first rank unrelated to the *Argophylli*. Jones' concept and treatment of *A. missouriensis* are, however, almost exactly those accepted here, and reflect a general agreement in the literature as to the limits and distribution of the species. The formae described by Gandoger are inconsiderable entities.

Astragalus melanocarpus first appeared in Fraser's Catalogue without description, being simply marked "M," i.e. from the Missouri. The only specimen in this country so named by Nuttall, the author of the Catalogue, is one from the Rocky Mountains (NY); it is probably not the type, but doubtless the plant referred to by Torrey & Gray as *A. missouriensis* (b)

in the Flora of North America. It remains puzzling to explain why Nuttall, when he came to describe the species, did not take up his own epithet *melanocarpus,* or at least cite it in synonymy. As a valid proposition *A. melanocarpus* dates from Richardson's listing of the name with a reference to Nuttall's description of *A. missouriensis.* It thus became an exact synonym.

Astragalus missouriensis is closely related to *A. amphioxys,* and has almost everything in common with it except the pod. Where their ranges overlap along the Rio Grande, it is nearly impossible to name flowering material with assurance. Apart from the shape of the legume, almost invalidated as a criterion by the variety described below, the form of its attachment provides a valuable character. In all forms of *A. missouriensis* the pod is strongly attached to the receptacle, even at maturity, remaining there during dehiscence and sometimes persisting on the withered peduncles until the second year. This is in striking contrast to *A. amphioxys,* where the pod is articulate with the receptacle and promptly deciduous, dehiscence usually occurring after it has fallen. The same is true of the related *A. cymboides,* which combines in its pod the straight, compressed form of *A. missouriensis* var. *typica* with the articulation of *A. amphioxys;* while the reverse combination is found in *A. missouriensis* var. *amphibolus.*

There is some conflict in the literature as to whether the pod of *A. missouriensis* is compressed or obcompressed at maturity. It has been described as "transversely dilated" (Nuttall), "truly obcompressed but often appearing compressed" or "compressed" (Gray),"somewhat obcompressed" (Jones), and "compressed" (Rydberg). It seems that the fully formed fruit, before the pulpy walls have begun to dry out, is nearly terete, or a little dorsiventrally compressed, as shown in Jones' figure. Being nearly round and straight, it may fall at any angle in the press, and its true shape is thus contorted in drying. Pods dried without pressure or maturing naturally on the plant eventually become laterally compressed. The stiff sutures then represent the greatest diameter of the fleshy pod, while the valves have shrunk inward, the lateral obtuse angles being formed by the pressure of the growing seeds within.

4b. var. **amphibolus,** var. nov.

A var. *typico* legumine oblique arcuato-lunato semper obcompresso, sutura ventrali concava, nec oblongo recto demum compresso, suturis aequaliter convexis rectisve, absimilis. Ab affinis *A. amphioxyi* Gray formis omnibus praesertim legumine cum receptaculo haud articulato diu persistenti differt. Calycis tubo 7-9 mm., dentibus 2-2.5 mm. longis; vexillo circa 25 mm., carina 20-22 mm. longis.

Type.—Mancos, Montezuma Co., Colorado, Baker, Earle & Tracy No. 56 (Herb. New York Botanical Garden).

Distribution.—Dry hillsides, often in sagebrush, up to 7000 ft. altitude, from southern Colorado to adjacent Utah (?and New Mexico).

Exsiccata.—COLORADO. *Conejos Co.:* Los Pinos, Baker No. 426 (PO).[3] *Garfield Co.:* Glenwood Springs, Diehl in 1899 (PO). *Montezuma Co.:* Mancos, Baker et al.

[3] The village of Los Pinos is actually just south of the Conejos County line in Rio Arriba Co., New Mexico, but the label states that the plant was collected in Colorado.

No. 56 (NY, type, CAS, M, PO). Cortez to Mances. Mrs. Stone No. 485 (NY). *Montrose Co.:* Cimarron, Baker No. 73 (PO), 331 (M, NY, PO). UTAH. Grand Co.: La Sal Mts., Jones in 1914 (PO). *San Juan Co.:* S. of Monticello, Rydberg & Garrett No. 9153 (NY). Monticello, Ripley & Barneby No. 5391 (CAS).

The type of the proposed variety was determined by Jones as *A. amphioxys*, which it resembles in the arcuate and oblique legumes; but this is persistent as in *A. missouriensis*, which it resembles in all other particulars. Moreover the often woody caudex and the altitude of its occurrence both point to a closer relationship with the latter than with *A. amphioxys*. The distribution of this variety on the borderland where the major areas of *A. amphioxys* and *A. missouriensis* meet, and its intermediate position as regards the form of the legume, have suggested the epithet *amphibolus*.

Such specimens as were known to Rydberg were distributed pretty evenly among his species of *Xylophacos*. His own collection from Monticello he referred to *X. argophyllus*, that of Mrs. Stone and Baker No. 426 to *X. brachylobus*, and Baker No. 46 to *X. cyaneus*. It is possible that the figure of *A. missouriensis* var. *cuspidocarpus* in Jones, Rev. Astrag. Pl. 50 may depict this form; it would be a fair portrait of the fruit of var. *amphibolus*, but there is no telling the source of the model.

5. ASTRAGALUS CYMBOIDES Jones

Astragalus cymboides Jones, Proc. Calif. Acad. Sci. II, **5**:650. 1895, exclus. typ. cit.; Rev. Astrag. 212, Pl. 50. 1923; Tidestr., Cont. U. S. Nat. Herb. **25**:328. 1925; Graham, Ann. Carn. Mus. **26**:247. 1937. *Xylophacos cymboides* (Jones) Rydb., Bull. Torr. Bot. Cl. **40**:49. 1913; op. cit. **52**:230. 1925; Fl. Rocky Mts. 505. 1917; N. Amer. Fl. **24**:299. 1929.

A. amphioxys Gray var. *cymbellus* Jones, Rev. Astrag. 215, Pl. 51. 1923, quoad fruct.

Subacaulescent, forming low rounded tufts, the few stems reduced to scarcely elongating crowns or evident and up to 3 cm. long, prostrate, radiating from the summit of a taproot; herbage densely canescent with appressed, silvery, dolabriform hairs; stipules ovate-deltoid, acute or the upper acuminate, 5-8 mm. long, closely imbricated to shortly discrete; leaves 2.5-10 cm. long, the deciduous or feebly persistent petioles about equalling the rachis; leaflets (5) 9-15, broadly oblanceolate to elliptic or obovate, 5-15 (18) mm. long, rounded or acutish at apex, equally strigose-canescent on both faces; peduncles commonly shorter than the leaf, stout, reclinate in fruit, 2.5-7.5 cm. long; racemes shortly 4-7 (12) -flowered, scarcely elongating in fruit, 0.5-2.5 cm. long; calyx strigose with mixed light and dark hairs, the cylindric tube 5-7 mm., the subulate teeth 1-2 mm. long; corolla ochroleucous or tinged with sordid purple, the banner 16-17 mm., the wings 13-14.5 mm., the obtuse, purple-tipped keel 12-13.5 mm. long; pod oblong to linear-oblong or narrowly oblong-ellipsoid, abruptly obtuse at base and cuspidate at apex, straight or nearly so, 2-3.5 cm. long, fleshy and subterete when first fully formed, at maturity and in drying becoming strongly compressed its whole length parallel with the sutures, 7-8.5 mm. high and 4-5 mm. broad, the sutures then very prominent and carinate, the valves composed of a leathery inner and a papery outer skin separated by a thin layer of spongious tissue, the strigose, unmottled, reticulate epicarp in dehiscence separating from the endocarp along the ventral suture and folding back as two exfoliating wings; seeds (?).

Type-Locality.—"Cottrell's Ranch, Henry Mts., Utah," according to Jones, but actually Huntingdon, Utah; collected by M. E. Jones in 1894.

Distribution.—Clay banks, cobblestone bluffs, or along gulches in the badlands of the Navajo Basin, Utah.

Exsiccata.—UTAH. *Carbon Co.:* Price, Jones in 1898 (PO). Farnham, Jones in 1898 (PO). *Emery Co.:* Huntingdon, Jones No. 5464j (PO, type, NY). Emery, No. 5445f (NY), in 1894 (PO). Spring Glen, in 1896 (G, PO, NY). San Rafael Swell, 28 May 1914 (PO, at least as to the fruiting element, type of *A. amphioxys* var. *cymbellus*). Greenriver, in 1895 (PO). E. of Castle Dale, Ripley & Barneby No. 4705 (CAS). *Uintah Co.:* reported by Graham, l. c.

The first specimen cited in the original description of *A. cymboides* is Jones No. 5658q, from the Henry Mts., Utah, and this was regarded by Rydberg as the type. However the specimen in question is not the plant described by Jones, but belongs to *A. Chamaeleuce,* and actually formed the type of *A. cicadae* var. *laccoliticus* published by Jones in the same paper. The second collection mentioned by Jones under *A. cymboides* as his No. 5464j, which agrees with the description and is here held to be the actual type.

Astragalus cymboides is a distinct and local species, though manifestly related to *A. missouriensis* and *A. amphioxys,* from which it is readily separated by its smaller, commonly paler corolla, and curiously dehiscent, cellular legume. In the early decidous pod it approaches *A. amphioxys,* and there are two anomalous collections at hand which suggest that the species intergrade, or perhaps hybridize, where they occur together. Thus in Jones' specimen from lower Cross, Utah, in 1898 (PO), the pods reach a maximum length of 3.5 cm. and are slightly curved; but the dehiscence is characteristic of *A. cymboides,* to which the collection is best referred. In the plant obtained by Jones at Greenriver, Utah, in 1915 (PO), the corolla is large and purple with the banner 24 mm. long, and while the pods are straight and rather cellular in texture, they are sometimes dorsally compressed, and apparently the epidermis does not exfoliate in age. This state is exactly intermediate between *A. cymboides* and *A. amphioxys* var. *vespertinus;* and it is perhaps significant that typical material of both has been secured in the neighborhood.

The plant described by Jones as *A. amphioxys* var. *cymbellus* presents a similar problem, combining as it does the large purple flower of *A. amphioxys* with precisely the pod of *A. cymboides.* But in this case a mixture of material, rather than heredity, may be the solution. The type of var. *cymbellus* consists of three small plants in very advanced fruit (PO, No. 24697) which cannot be separated in any way from authentic *A. cymboides* (cf. Jones' figure of the pod of each; they are identical), and a fragment (PO, No. 24696) with two imperfect flowers which would pass anywhere for *A. amphioxys.* It should be recalled that the latter is not uncommon in the San Rafael Swell, and the flowering element of var. *cymbellus* probably belongs to it. Although Jones claimed (l. c.) that var. *cymbellus* was "common . . . in the western side of the Navajo Basin . . .", the material so named in his herbarium, apart from the doubtfully conspecific flower of the type, is all *A. cymboides* in the strictest sense.

6. ASTRAGALUS CHAMAELEUCE Gray

Astragalus Chamaeleuce Gray in Ives, Rep. Colo. River, Bot. 10. 1860; Proc. Amer. Acad. **6**:222. 1863; Sheld., Minn. Bot. Stud. **1**:129. 1894; Coult. & Nels., Man. 286. 1909, exclus. syn.; Graham, Ann. Carn. Mus. **26**:245. 1937. *Phaca pygmaea* Nutt. ex T. & G., Fl. N. Amer. **1**:349. 1838. *Tragacantha pygmaea* (Nutt.) O. Kze., Rev. Gen. 941. 1891. *Xylophacos pygmaeus* (Nutt.) Rydb., Bull. Torr. Bot. Cl. **32**:1906; op. cit. **52**:230. 1925; Fl. Rocky Mts. 505. 1917; N. Amer. Fl. **24**:300. 1929. *Astragalus pygmaeus* (Nutt.) Jones, Rev. Astrag. 210. Pl. 49. 1923; non *A. pygmaeus* Pall. (1800).

A. cicadae Jones, Zoë **3**:292. 1893; Eastwood, op. cit. 16. 1893, nomen. *A. Chamaeleuce* var. *cicadae* (Jones) Jones, Cont. W. Bot. **8**:12. 1898. *A. pygmaeus* var. *cicadae* (Jones) Jones. Rev. Astrag. 211. 1923.

A. cicadae var. *laccoliticus* Jones, Proc. Calif. Acad. Sci. II, **5**:672. 1895. *A. pygmaeus* var. *laccoliticus* (Jones) Jones, Rev. Astrag. 211. 1923. *A. Chamaeleuce* var. *laccoliticus* "Jones" ex Rydb., N. Amer. Fl. **24**:300. 1929, in syn., errore.

Subacaulescent or with evident, prostrate stems up to 6 cm. long, clustered on the summit of a slender taproot or the divisions of a shortly branched caudex, forming small, depressed tufts; herbage densely canescent with closely appressed, somewhat scabrous, dolabriform hairs, the vesture on the upper surface of the leaflets often assuming a golden-green hue when dry; stipules ovate, scarious, strigose (sometimes with dark hairs), 2-6 mm. long, either all imbricated or the upper discrete; leaves (3) 5-8 (11) cm. long, the slender, almost entirely deciduous petioles about equalling the rachis; leaflets (1) 5-13 (17), suborbicular, broadly obovate or elliptic, commonly obtuse but sometimes acutish or even acute, 4-13 mm. long; racemes 3-9-flowered, becoming 1-2 cm. long; peduncles shorter than the leaf, 1.5-5 cm. long, arcuate-reclinate in fruit; calyx black-strigose, or with some or nearly all the hairs white, the cylindric tube 6-8 mm., the subulate teeth 1.5-2 mm. long; corolla ochroleucous with purple-tipped keel, suffused with dull purple, or purple-pink throughout, the banner 17-23 mm., the wings 16-18 mm., the obtuse keel 14-16 mm. long; pod obliquely oblong-ovoid, slightly obcompressed toward the very obtuse base, gently arcuate upward into the short, laterally compressed beak 2-3.5 cm. long, 7-10 mm. in greatest diameter, scarcely, if at all, sulcate along the sutures and then only on the ventral side, the valves very fleshy when young, about 3 mm. thick (less when dry), the walls composed of a leathery inner and a papery outer integument separated by a layer of large cells which become alveolate and spongy-filamentous in age, the epicarp at first strongly reticulate but usually becoming smooth at length, straw-colored and commonly mottled, cinereous-strigose and becoming glabrate; seeds (?).

Type-locality.—On the hills of Ham's Fork of the Colorado of the West (i. e. southwestern Wyoming); collected by Thomas Nuttall.

Distribution.—Clay knolls, bluffs and badlands in the basins of the Green and Grand rivers in southern Wyoming, Utah and western Colorado.

Exsiccata.—COLORADO. *Garfield Co.:* 36 miles N. of Loma, Ripley & Barneby No. 5481. *Mesa Co.:* Grand Junction, Eastwood No. 10 in 1892 (PO, type of *A. cicadae*, CAS, G, M). De Beque, Osterhout No. 4467 (NY). *Rio Blanco Co.:* NE. of Meeker, Ripley & Barneby No. 7771. UTAH. *Duchesne Co.:* S. of Theodore, Jones

in 1908 (PO). Theodore, Jones, 12, 14 and 19 May 1908 (PO). Myton, Jones in 1908 (PO). SE. of Myton, Graham No. 7863 (CAS). E. of Fruitland, Ripley & Barneby No. 4656 (CAS). *Emery Co.:* Nine-mile Canyon, Jones in 1896 (NY, PO). *Garfield Co.:* Cottrell's Ranch, Henry Mts., Jones No. 5658q (PO, type of *A. cicadae* var. *laccoliticus*). *Uintah Co.:* White River, Jones in 1908 (PO). Dragon, Jones in 1908 (PO). WYOMING. Rocky Mts., Nuttall (NY, presumable isotype of *Phaca pygmaea*). sine loc., Parry, NW. Wyo. Exped. in 1873 (G). *Lincoln Co.:* Opal, Ripley & Barneby No. 7865a. *Sweetwater Co.:* Green River, Jones in 1896 (PO). S.E. of Green River, Rollins No. 2256 (G). Blacks Fork, SW. of Green River, Ripley & Barneby No. 7890. Granger, Jones in 1896 (PO). *Uinta Co.:* E. of Lyman, Rollins No. 2381 (G). N. of Lyman, No. 1659 (NY). Fort Bridger, A. Nelson No. 4605 (G, NY), Ripley & Barneby No. 7844 (CAS).

The name *A. Chamaeleuce* was proposed as a substitute for *Phaca pygmaea,* the combination *A. pygmaeus* having already been used by both Pallas and DeCandolle, and was first applied by Gray to the plant which later became the type of *A. Newberryi* (q. v.). More than half a century elapsed between Nuttall's original collection of *Phaca pygmaea* and its rediscovery by Miss Eastwood in 1892. Jones, who had been using the name *Chamaeleuce* for *A. argophyllus* Nutt. (at that time supposed to be a synonym of *A. glareosus:* cf. Zoë 3:292. 1893), described Miss Eastwood's plant as *A. cicadae,* and continued to maintain it as a variety of his (illegitimate) *A. pygmaeus* long after the real identity of *A. Chamaeleuce* had been established. No explicit reason was ever advanced for this disposition of *A. cicadae,* and in the Revision of Astragalus, where Jones treated it as a race replacing the typical form to the south of the Uintahs, he admitted that "all sorts of intergrades occur so that it seems hardly more than a form of the species." In fact the types of *A. cicadae* and *Phaca pygmaea* differ only in so far that the latter is somewhat depauperate. The var. *laccoliticus* differs, according to the author, in having purple flowers, acute or acutish leaflets, and smooth (i.e. not reticulate) pods. The type and only known collection consists of a fragment in flower and a few mature plants from which the pods have already fallen. The characters stressed by Jones, in constant association, might support its retention; but bright purple or dull purplish flowers exist elsewhere in the range of the species combined with obtuse leaflets; a tendency towards acute leaflets is manifest in several collections of ochroleucous-flowered *A. Chamaeleuce;* while the smooth pod is characteristic at this late stage of growth, as Jones himself (Rev. Astrag. l. c.) infers. There seems to be no firm basis on which to rest any segregate from the species.

Astragalus Chamaeleuce is most closely related, through *A. cymboides,* to the malpighiaceous-haired *amphioxys-missouriensis* alliance, though in itself very distinct. *Astragalus cymboides,* which exhibits an almost parallel range of variation in color and length of corolla and in shape of leaflets, is immediately distinguished from *A. Chamaeleuce,* where they grow together, by its straight and narrow, strongly compressed legume. *Astragalus musiniensis,* in which the pod is similar in texture and which also is endemic to the Navajo Basin, differs in its strictly acaulescent habit, glabrescent, many-nerved stipules, persistent petioles and few leaflets, and seems both in these characters and in the obscure-

ly dolabriform pubescence to be more nearly allied to *A. Newberryi* and *A. eurekensis*, in spite of the cellular texture of its pod.

Graham reports (l. c.) that in the Navajo Basin, where *Astragalus Chamaeleuce* is not uncommon, it is known locally as "Popper."

7. ASTRAGALUS MUSINIENSIS Jones

Astragalus musiniensis Jones, Proc. Calif. Acad. Sci. II, **5**:671. 1895; Rev. Astrag. 211, Pl. 49. 1923. *Xylophacos musiniensis* (Jones) Rydb., Bull. Torr. Bot. Cl. **40**:49. 1913; op. cit. **52**:231. 1925. N. Amer. Fl. **24**:300. 1929.
A. musiniensis var. *Newberryoides* Jones, Rev. Astrag. 212. 1923.

Strictly acaulescent, the leaves and peduncles tufted on the thick enlarged crowns of a tough taproot often 1 cm. thick; herbage strigose and often canescent with appressed, sericeous hairs, these basifixed or nearly so, but tapering, obliquely attached and obscurely calcarate at base; stipules densely imbricated, ovate-lanceolate, 6-8 mm. long, sparingly hirsute and ciliate when young, becoming glabrate, castaneous, prominently 5-9-nerved; leaves erect, (3) 5-12 cm. long, the wiry petioles much exceeding the short rachis, at length recurved and at least at base persistent, forming a thatch along the scarcely elongating divisions of the caudex; leaflets (solitary in a few early leaves) 3-5, oblanceolate, elliptic or lozenge-shaped, acute, or acuminate and rounded at the immediate apex, 1-3.5 cm. long, the terminal and upper pair commonly approximate; racemes (1) 3-6-flowered, less than 1 cm. long in fruit, on stout, at length reclinate-recurved and persistent peduncles (1.5) 2.5-6 cm. long; calyx strigose-hirsute with dark and light hairs in varying proportions, the narrowly cylindric tube 9-11 mm., the subulate teeth 1.5-4 mm. long; corolla purple, the banner 21-26 mm., the wings 22-24 mm., the keel 18-20 mm. long; pod obliquely ovoid-acuminate, obcompressed toward the obtuse base and curved upward through 90° or less into the laterally compressed, deltoid beak, (1.5) 2-3.5 cm. long, 1-1.4 cm. in greatest diameter, sulcate ventrally but not or scarcely so dorsally, the fleshy valves shortly hirsute with ascending or spreading hairs when young, in age glabrate, castaneous or stramineous, nearly smooth and obscurely if at all reticulate, the space between the epicarp and the endocarp then becoming cellular-spongy and 1.5-2 mm. thick; seeds brown, 2.6-3 mm. long.

Type-locality.—Two miles south of Ferron, Utah, on clay slopes, at about 6000 ft. altitude; collected by M. E. Jones in 1894.

Distribution.—Clay banks and gulches, in alkaline soils, along the detrital foothills on the west side of the Navajo Basin, Utah.

Exsiccata.—UTAH. *Carbon Co.:* Price, Jones in 1894, in 1898 (PO). *Emery Co.:* S. of Ferron, Jones No. 5454a (PO, type), Ripley & Barneby No. 4741 (CAS). Spring Glen, Jones in 1896 (G, NY, PO). Miller Canyon, Jones in 1910 (PO). San Rafael Swell, Jones in 1914 (PO, type of var. *Newberryoides*).

A highly localized and distinct species, *A. musiniensis* most closely resembles *A. Newberryi* and *A. eurekensis* in its acaulescent habit, in the persistence of the petioles as a thatch about the root-crown, and in its relatively few leaflets. The tendency of the pubescence towards a median attachment and the curious cellular texture of the mature pod suggest a relationship at least as close with *A. Chamaeleuce* of the same region, from which, however, the few,

large leaflets, the heavy rootstock and more strongly curved pod amply distinguish it. The var. *Newberryoides* (*nomen infaustum!*) is merely a form in which the pubescence of the pod, slightly more copious but no longer than in plants from the type-locality of the species, is spreading and not strictly ascending or appressed; but this seems to occur frequently, perhaps characteristically, in the immature state.

The legume of *A. musiniensis* is very fleshy when first formed, the body of the valves, between the inner and outer integuments, being composed of large cells heavy with pulp, but as it matures the moisture evaporates, leaving a deep layer of transparent, honeycomb tissue. Thus the ripe pod, which is tardily dehiscent, becomes light and spongy, and could be blown far by the wind. But considering the narrow range of the species this method of dispersal appears ineffective, unless, as is most probable, there are limiting ecological factors.

8. ASTRAGALUS SHORTIANUS Nutt.

Acaulescent and densely tufted or rarely subacaulescent, the several prostrate or shortly ascending stems 1-2.5 cm. long, clustered on the summit of a taproot; herbage strigose or appressed-sericeous with basifixed hairs; stipules closely, or at length loosely imbricated, the uppermost rarely discrete, broadly lanceolate, castaneous, (4) 9-12 mm. long; leaves (4) 10-20 (25) cm. long, the almost wholly deciduous petioles about equalling the rachis; leaflets ovate, obovate, broadly elliptic, somewhat lozenge-shaped or suborbicular, commonly obtuse, but sometimes acute or obscurely retuse, (5) 8-25 mm. long, equally pubescent on both faces; peduncles stout, striate, shorter than or occasionally equalling the leaves, at length arcuate-reclinate; racemes 6-18-flowered, rather loose and (1) 2-6 (11) cm. long in fruit; calyx-tube cylindric, 6-8 mm. long, the filiform or linear-subulate teeth 2-4.5 mm. long; corolla bright purple, the banner (16) 18.5-22 mm., the wings (14) 17-20 mm., the keel 14-17 mm. long; pod obliquely ovoid-acuminate, (2) 2.5-4.5 cm. long, obtuse at base, obcompressed except towards the apex where gradually or rather abruptly arched upward into a deltoid or narrowly 3-angular, laterally compressed beak, widely sulcate usually along both sutures, the ventral suture very thick and prominent, the dorsal less so, often inflexed to form a narrow and incomplete partition up to 2.5 mm. deep, the valves very thick and fleshy, at maturity becoming cellular-spongy and at least 1 mm. thick, the pericarp somewhat rugose, unmottled, strigulose or finely canescent when young.

With some reluctance I am following Jones' reduction of *A. cyaneus* to varietal status under *A. Shortianus;* the two races are contrasted in the ensuing key.

KEY TO THE VARIETIES OF A. SHORTIANUS

Herbage densely sericeous with fine, long, filiform hairs; calyx loosely hirsutulous, mostly with light hairs, the teeth ciliate; leaflets 7-17 (19) ..... var. *typicus*

Herbage strigose with short, somewhat flattened hairs, these obscurely calcarate at base as though dolabriform; pubescence of the calyx similar, strictly strigose, often dark, the teeth not ciliate; leaflets 17-25 ..... var. *cyaneus*

8a. var. **typicus**, nom. nov.

Astragalus Shortianus Nutt. var. *typicus* Barneby, nom. nov. *A. Shortianus* Nutt. ex T. & G., Fl. N. Amer. **1**:331. 1838; Gray, Proc. Amer. Acad. **6**:210. 1864; Wats., Bot. King, Append. 441. 1871; Port. & Coult., Syn. Fl. Colo. 27. 1874; Rothrock, Bot. Wheeler Exped. 95. 1878, exclus. syn.; Sheld., Minn. Bot. Stud. **1**:148. 1894; Rydb., Fl. Neb. **21**:49, Pl. X, fig. 61-63. 1895; A. Nels., Bull. Wyo. Exper. Sta. **28**:97. 1896; Jones, Cont. W. Bot. **10**: Pl. 4. 1902; Rev. Astrag. 205, pro. max. parte, Pl. 45, 46. 1923; Coult. & Nels., Man. 286. 1909, exclus. syn.; Britt. & Br., Ill. Fl., ed. 2, **2**:383, fig. 2548. 1923; Clements, Rocky Mt. Flrs., ed. 3, Pl. 29, fig. 19. 1928. *Tragacantha Shortiana* (Nutt.) O. Kze., Rev. Gen. 944. 1891. *Xylophacos Shortianus* (Nutt.) Rydb. ap. Small, Fl. SE. U. S. 1332. 1903; Fl. Rocky Mts. 504. 1917; Bull. Torr. Bot. Cl. **52**:151. 1925; Amer. Journ. Bot. **15**:593, Pl. XLV, fig. E. 1928; N. Amer. Fl. **24**:295. 1929; Fl. Prair. Pl. 474, fig. 318. 1932.

A. humilis Geyer ex Hook., Journ. of Bot. **6**:211. 1847; Gray, Pl. Wright. **1**:52. 1850, in nota; non MB. (1808).

A. cyaneus sensu Gray, Proc. Acad. Philad. II, **7**:60. 1891; non alibi.

Densely sericeous throughout, except the hirsutulous calyx; stipules (5) 9-12 mm. long; leaflets 7-17 (19), prevailingly ample and up to 2.5 cm. long; raceme in fruit (1) 2-6 cm. long; banner 18.5-22 mm. long.

Type-locality.—Rocky Mountains, towards the plains of the Oregon (i.e. Wyoming); collected by Thomas Nuttall.

Distribution.—Plains and foothills, up to 8500 ft. altitude, often in granitic soils, along the eastern face of the Rocky Mountains from (?central and) southern Wyoming (? and the Black Hills of South Dakota) to northern New Mexico; erroneously reported from Arizona (Rydberg, 1932) and western Colorado (Jones, 1923).

Exsiccata (*selecta*).—COLORADO. *Boulder Co.:* Boulder, Tweedy No. 5155, 5639 (NY). *Denver Co.:* Denver, Rydberg & Vreeland No. 5976 (NY). *Douglas Co.:* Castle Rock, Beetle No. 1479 (CAS, NY). *El Paso Co.:* Colorado Springs, Jones No. 80 (NY), in 1878 (PO). SW. of Peyton, Ripley & Barneby No. 7667 (CAS). *Jefferson Co.:* Clear Creek, Wolf in Wheeler's Exped. No. 241 (G). *Larimer Co.:* Fort Collins, Baker in 1896 (NY, PO). Virginia Dale, Ripley & Barneby No. 7700. *Las Animas Co.:* Branson, Eggleston No. 20170 (G, NY). NEW MEXICO. Union *Co.:* Emery Gap to Branson, Eggleston No. 20159 (NY). *Santa Fe Co.:* Santa Fe, A. A. & E. G. Heller, 20 May 1897 (PO). WYOMING. *Albany Co.:* Laramie, A. Nelson No. 64 (G). Sand Creek, No. 7021 (G, NY, PO). *Laramie Co.:* Cheyenne, Cleburne in 1874 (PO).

Astragalus Shortianus, a distinctive species of the Atlantic slope of the Rockies which barely passes over, near Santa Fe, New Mexico, into the drainage of the Rio Grande, has been well understood, except for some early confusion with the then little known *A. missouriensis* of the same region. Jones included in it *A. iodopetalus,* which differs in its glabrescent foliage and glabrous pod of much thinner texture. *Astragalus humilis* Geyer has generally been referred to *A. Shortianus,* and Hooker's description agrees with no other known species. It is curious, nevertheless, that *A. Shortianus* has not been collected in the Black Hills (the type-locality of *A. humilis*) in recent years; at least it is not listed either in Rydberg's Flora (Cont. U. S. Nat. Herb. 3:463, sequ. 1896) or in the more recent floristic survey of McIntosh (Black Hills Engineer **19**:117, sequ. 1931). No part of Geyer's original collection has been seen—I presume that none exists in American herbaria—so that the

name remains to some extent doubtful. But since it is by many years antedated by a proposal of Marschall von Bieberstein, the problem of its identity is academic.

The northern limit of the species is not certainly established. Sterile plants apparently of *A. Shortianus* var. *typicus* were seen by Mr. Ripley and me in 1946 on dry hills 2 miles north of Kirby, Hot Springs Co., Wyoming, at a point about 200 miles due west of the Black Hills, and as far northwest of the nearest station certainly recorded.

8b. var. CYANEUS (Gray) Jones

Astragalus Shortianus Nutt. var. *cyaneus* (Gray) Jones, Cont. W. Bot. **8**:5. 1898; op. cit. **10**:65, Pl. 4 .1902, exclus. syn.; Rev. Astrag. 206, Pl. 46. 1923. *A. cyaneus* Gray, Pl. Fendl. 34. 1849; Sheld., Minn. Bot. Stud. **1**:148. 1894; Standl., Cont. U. S. Nat. Herb. **13**:193. 1910. *Tragacantha cyanea* (Gray) O. Kze., Rev. Gen. 944. 1891. *Xylophacos cyaneus* (Gray) Rydb., Bull. Torr. Bot. Cl. **52**:154. 1925, quoad nomen, exclus. specim. cit. plur.; N. Amer. Fl. **24**:297. 1929, vix nisi quoad nomen.

A. jemensis A. Nels., Amer. Journ. Bot. **21**:574. 1934.

A. Shortianus var. *minor* sensu Jones, Cont. W. Bot. **8**:6. 1898, pro parte; vix Gray.

A. Shortianus sensu Woot. & Standl., Cont. U. S. Nat. Herb. **19**:365. 1915; Coult. & Nels., Man. 286. 1909; amb. pro parte, non Nutt.

Strigose throughout, even as to the calyx, canescent or at length greenish; stipules 4-7 mm. long; leaflets 19-25, prevailingly small, 5-18 mm. long; raceme in fruit loose, (2) 5-11 cm. long; banner 16-20 mm. long.

Type-locality.—Santa Fe, New Mexico, on gravelly hills and low mountains among rocks; collected by August Fendler in 1847.

Distribution.—Hillsides and stony banks in the pinyon-zone along the upper waters of the Rio Grande in north-central New Mexico.

Exsiccata.—NEW MEXICO. *Bernalillo Co.:* Between Albuquerque and Los Cerrillos, McKelvey No. 2375 (G). *Santa Fe Co.:* Between Golden and Madrid, E. F. Castetter No. 322 (RM, type of *A. jemensis*). Madrid, No. 230 (RM). SW. of Madrid, Ripley & Barneby No. 7560 (CAS). Santa Fe, Fendler No. 148 (G, type of *A. cyaneus*, NY, P), A. A. & E. G. Heller, 20 June 1897 (NY, PO), Goodding No. 84-40 (RM), Ripley & Barneby No. 7544. *Taos Co.:* W. of Ranches of Taos, No. 7550 (CAS).

When restricted to the collections closely resembling in stature, pubescence and legume the plant originally collected by Fendler, *A. cyaneus* proves to be a local but distinct race which I have hesitated to subordinate to *A. Shortianus;* but the pods are scarcely distinguishable either in shape or texture, and the ultimate criteria are merely ones of vesture and number of leaflets.

This variety has been interpreted variously and often inaccurately, more than one distinct plant having been referred to it, or itself having been reduced to *A. Shortianus*. During the fifteen years which elapsed between the original publication of *A. cyaneus* and his Revision of the genus (1864), Gray had enlarged or changed his concept considerably to include material of what he later separated as *A. amphioxys*, as well as some dwarf forms of *A. missouriensis* or perhaps of *A. Shortianus* var. *typicus*. It was at this point that he published *A. Shortianus* ? var. *minor*, giving as synonymous "*A. cyaneus* Gray, Pl. Fendl. . . . (magna pro parte)." Since *A. cyaneus* of Plantae Fendlerianae was based on a single collection, the dubious variety *minor* might be interpreted as an exact synonym, and perforce be adopted as the earliest varie-

tal name. But the description of the variety, the qualifying "magna pro parte," and the extensive range cited ("from the southern frontier of New Mexico and western Texas to Nebraska . . .") are evidence that Gray had in mind, as var. *minor*, a large southern element of *A. amphioxys* and a northern one of either *A. Shortianus* var. *typicus* or *A. missouriensis*. It is puzzling, however, to explain the absence from the Revision of any further reference to Fendler's plant (the residue, as I suppose, of *A. cyaneus*, magna pro parte) or how, if excluded from var. *minor*, it was disposed of. Subsequently, however, when separating from *A. Shortianus* var. *minor* the species *A. amphioxys*, Gray stated clearly that he considered *A. cyaneus* synonymous with *A. missouriensis*. In view of this ambiguity it has seemed wise to reject the varietal epithet *minor* in application to *A. cyaneus*, and to adopt Jones' unequivocal combination *A. Shortianus* var. *cyaneus*.

Partly owing, no doubt, to the obscurity of Gray's treatment, the concept of *A. cyaneus* went into eclipse. Jones published a figure of the original plant in 1902, but he seems never to have recognized its characters clearly, nor to have fully extricated it from the association of *A. Shortianus* var. *minor*. The description of var. *cyaneus* in his Revision of Astragalus is a good one, but his peculiar reference there to var. *minor*, and his statement that the former "is the common form of the Rio Grande to Texas" reveal an essential lack of understanding. More recently Rydberg revived the species, transferring it to *Xylophacos*. Here (1925, l. c.), after some discussion of the nomenclature, in which he took the opportunity to correct some early errors of his own and make a couple more for good measure,[4] he cited a considerable mass of material from Oklahoma, Texas, New Mexico, Colorado and Arizona. Of the twenty-five numbers cited eighteen have been examined by me, and of these only one (the type) prove to belong to *A. cyaneus*, twelve to typical *A. missouriensis* and one to its var. *amphibolus*, four to *A. tephrodes*, and one to *A. amphioxys* var. *vespertinus*. The specimen reported from Arizona, Rothrock No. 1112 (G), was recorded by Rothrock himself (as *A. Shortianus*, in Bot. Wheeler Exped. 95) as having been gathered in New Mexico. It forms the only basis as far as I have discovered for the inclusion of Arizona in the range of *Xylophacos cyaneus* as given in the North American Flora; and in any case the material belongs to *A. tephrodes*. It should perhaps be noted that in his final monograph Rydberg's description of *X. cyaneus* disagrees strikingly as to length of leaf and peduncle, number and size of leaflets, and even as to the dimensions of calyx, corolla and legume, with the type of *A. cyaneus*, and seems to refer only more or less loosely to a part of Rydberg's extraneous elements. In addition the synonym "*A stipularis* Jones, Cont. W. Bot. 7:655. 1895" (apart from the fact that it does not belong there) is misleadingly cited; in binomial form it appeared only as a *nomen provisorium*, having been published on the preceding page as *A. arietinus* var. *stipularis* Jones.

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4 Rydberg criticized Jones for regarding *A. cyaneus* as a synonym of *A. missouriensis* var. *cuspidocarpus*. In point of fact Jones (Rev. Astrag. 213) referred to the latter (nomenclaturally indefensible) variety only "*A. Shortianus* var. *minor* Gray, in part," which, as shown above, is not at all the same thing; Jones recognized *A. cyaneus* elsewhere in the Revision (p. 206) as a variety of *A. Shortianus*.

Astragalus jemensis, as to the type-specimen designated by Nelson, unquestionably belongs here. The description, however, was drawn from a mixture of *A. Shortianus* var. *cyaneus* and the related *A. iodopetalus* Greene. The character of the mature pod, as well as the trivial *jemensis* were taken from Castetter's fruiting specimen of the latter gathered in the Jemez Mts., New Mexico.

9. ASTRAGALUS UNCIALIS Barneby

Astragalus uncialis Barneby, Leafl. West. Bot. **3**:101, Pl. 1, fig. E. 1942; Proc. Calif. Acad. Sci. IV, **25**: 150. 1944; Ripley, Bull. Alp. Gard. Soc. **12**:66. 1944. cum ic. photogr.

Acaulescent, depressed, the 1-several crowns clustered on the summit of a vertical taproot, forming small tufts 6-12 cm. broad; herbage densely strigose-sericeous with fine, basifixed, closely appressed and ascending hairs; stipules closely imbricated, ovate-lanceolate, acute, 3-4 mm. long; leaves 1.5-7.5 cm. long, the slender petioles 1-4.5 cm. long, persistent at base and forming a thatch; leaflets 3-5 oblanceolate to elliptic or narrowly obovate, acute or rarely subobtuse, 0.5-1.7 cm. long, the three upper approximate and appearing palmate, the lower pair, when present, remote; racemes 1-3-flowered, very short, on scapiform, at length reclinate peduncles 0.5-3.5 cm. long, surpassed by the leaves; calyx strigose with long white silky hairs, the tube 10-12 mm., the subulate teeth 2-3 mm. long; corolla brilliant violet-purple, the banner about 28 mm., the narrow wings 25-26 mm., the keel 22-23 mm. long, the blades of the latter gently arcuate to the rounded apex; pod oblong-lanceolate, obtuse at base, nearly straight below and strongly obcompressed except in the arcuate-upcurved, deltoid-acute or acuminate, proriform, laterally compressed beak, 2.5-3 cm. long, 9-10 mm. wide and (at the middle) about 2 mm. high, the ventral suture prominent, the depressed dorsal less so or subfiliform, the valves coriaceous, 0.2-0.3 mm. thick, reticulate, obscurely rugulose on the angles, becoming stramineous and densely but finely strigose, sericeous-canescent when young; seeds (immature) brown, about 2 mm. long.

Type-locality.—Currant, Nye County, Nevada; collected by H. D. Ripley & R. C. Barneby in 1941.

Distribution.—Adobe clay banks and gravelly slopes in the foothills of calcareous mountains, Upper Sonoran zone, at about 5300 ft. altitude; known only from northeastern Nye County, Nevada.

Exsiccata.—NEVADA. *Nye Co.:* Currant, Ripley & Barneby No. 3563 (CAS, type), No. 4421 (CAS, G). Pancake Range, near Lockes, No. 4423.

A dwarf, condensed plant, with numerous crowns tufted on a heavy caudex and large, seemingly stemless flowers, *A. uncialis* somewhat resembles *A. Newberryi* in habit, but in the strigose pod, of rather thin texture for the section, it approaches *A. argophyllus*. The paucifoliolate leaves are characteristic.

10. ASTRAGALUS ARGOPHYLLUS Nutt.

Subacaulescent, or with developed, prostrate stems up to 1 (1.5) dm. long, rising from a tough and heavy rootstock or the more slender divisions of a branched caudex, forming cespitose or loosely matted plants; herbage and stems densely sericeous with closely appressed, ascending or sometimes spread-

ing, straight and parallel or somewhat sinuous but not matted, basifixed hairs; stipules membranous with green midrib, closely imbricated to discrete, 3-8 mm. long, the lower deltoid, acute or obtuse, the upper acuminate; leaves (2) 4-15 cm. long, the slender, almost wholly deciduous petioles about equalling the rachis; leaflets (7) 11-17 (21), narrowly obovate to elliptic, prevailingly acute or acutish, equally pubescent on both sides, 4-15 mm. long; peduncles (1) 3-9 cm. long, reclinate in fruit, surpassed by the leaf; racemes (2) 5-9-flowered, at first subcapitate, 0.5-2 (3) cm. long in fruit; corolla purple or purple-tinged, the banner 17-25 mm., the wings 15-21 mm., the keel 13-19 mm. long; pod obliquely ovoid, ovoid-lunate (or rarely lance-lunate), 1.5-2.5 (3.5) cm. long, 7-11 mm. in greatest diameter, obcompressed toward the obtuse base, abruptly narrowed above into the nearly straight to strongly incurved, laterally compressed, proriform beak, the ventral suture thick and commonly prominent or carinate (but at times depressed and sulcate below), the dorsal less prominent, not sulcate, the valves very fleshy when first formed, becoming stifflly leathery or woody, 0.3-0.5 mm. thick, reticulate and somewhat rugose, yellowish-brown when dry, unmottled, thinly pubescent or canescent when young; seeds dark brown, 2-3 mm. long.

A plastic species, *A. argophyllus* is composed of two perhaps insuffiicently distinct races, one mesophytic, the other xerophytic, separable as follows:

KEY TO THE VARIETIES OF A. ARGOPHYLLUS

Corolla brilliant purple, large, the keel 17-19 mm. long; vesture of the herbage and pod strictly appressed, strigose-sericeous; rootstock very stout and woody, but the stems slender, often elongated; plants of stiff moist soil along creeks and lake-shores, or of alkaline meadows ..... var. *typicus*

Corolla pale, the petals only tinged with purple, prevailingly smaller, the keel 13-17 mm. long; vesture of the herbage and usually also of the pod looser, composed largely or in part of spreading and incumbent hairs; rootstock relatively slender, the stems commonly tufted; plants of loose, dry soils on exposed ridges or hill-sides, often in sagebrush ..... var. *pephragmenoides*

10a. var. typicus, nom. nov.

Astragalus argophyllus Nutt. var. *typicus* Barneby, nom. nov. *A. argophyllus* Nutt. ex T. & G., Fl. N. Amer. **1**:331. 1838, exclus. syn.; Jones, Cont. W. Bot. **8**:5. 1898; op. cit. **10**: Pl. 15. 1902; Rev. Astrag. 206, Pl. 46. 1923; Tidestr., Cont. U. S. Nat. Herb. **25**:328. 1925. *Xylophacos argophyllus* (Nutt.) Rydb., Bull. Torr. Bot. Cl. **40**:49. 1913; op. cit. **52**:156. 1925; Fl. Rocky Mts. 505. 1917; N. Amer. Fl. **24**:298. 1929.

A. uintensis Jones, Proc. Calif. Acad. Sci. II, **5**:670. 1895, nomen provisorium. *Xylophacos uintensis* (Jones) Rydb., Bull. Torr. Bot. Cl. **32**:662. 1906; Fl. Rocky Mts. 505. 1917, pro parte.

A. argophyllus Nutt. var. *Martini* Jones, Rev. Astrag. 207, Pl. 47. 1923.

(?) *A. argophyllus* Nutt. var. *cnicensis* Jones, op. cit. 208, Pl. 46. 1923.

A. glareosus sensu H. & A., Bot. Beechey Voy. 334. 1840, quoad pl. cit.; T. & G., Fl. N. Amer. **1**:693. 1840; Gray, Proc. Amer. Acad. **6**:211. 1863; Wats., Bot. King 440. 1871; Sheld., Minn. Bot. Stud. **1**:146. 1894; non Dougl.

A. Chamaeleuce sensu Jones, Zoë **3**:294. 1893; Coult. & Nels., Man. 286. 1909; non Gray.

Root very heavy, with a thick woody crown; pubescence of the herbage closely appressed, silver-plated and shining, but sometimes with a few ascend-

ing hairs on petioles and peduncles; leaflets commonly remote, narrowly elliptic or lozenge-shaped and acute at both ends, occasionally obtuse on the early leaves; calyx strictly strigose; corolla brilliant pink-purple, drying bluish, the banner with a large white striate eye; banner 20-25 mm., keel 17-19 mm. long; pod strigose with rather long but appressed hairs, canescent when young.

Type-locality.—Vallies [sic] of the Rocky Mountains, near the sources of the Platte; collected by Thomas Nuttall.

Distribution.—Moist soil along creeks, lakeshores or alkaline meadows, southern Idaho in the valley of the upper Snake River, to adjacent Montana and Wyoming, northern Utah, and westwards across northern Nevada to the borders of California.

Exsiccata (*selecta*).—STATE UNKNOWN. Rocky Mts., Nuttall (G, NY, isotypes). Snake Country (perhaps at Snake Fort acc. H. & A., Bot. Beechey p. 338), Tolmie (G). IDAHO. *Bear Lake Co.:* Meadow Creek Ranger Station, Davis No. 749 (Poc). *Blaine Co.:* Picabo, Macbride & Payson No. 3020 (CAS, NY, PO). *Bingham Co.:* Fort Hall, Davis No. 91-32 (Poc). *Caribou Co.:* Soda Springs, W. W. Martin in 1901 (PO, type of *A. argophyllus* var. *Martini*). *Clark Co.:* Medicine Lodge Creek, Davis No. 3146 (Poc). *Jefferson Co.:* N. of Roberts, No. 301 (Poc). *Teton Co.:* W. of Driggs, No. 257 (Poc). MONTANA. *Beaverhead Co.:* Mcnida, A. & E. Nelson No. 5416 (G, labelled "Madison Co., Wyoming"). Dillon, Shear No. 3438 (NY). NEVADA. *Elko Co.:* Ruby Valley, Watson No. 281 (NY, in part). N. of Warm Creek, Ripley & Barneby No. 6450. *Eureka Co.:* Palisade, Jones No. 3833 (CAS, G, NY, PO). *Humboldt Co.:* 10 miles W. of Battle Mt., Ripley & Barneby No. 6168 (CAS). *Lander Co.:* 8 miles NW. of Austin, No. 5930 (CAS). *Nye Co.:* Sunnyside, No. 3613 (CAS). *Washoe Co.:* Reno, Jones in 1897 (PO). *White Pine Co.:* Centerville near Aurum, Jones in 1893 (PO). Monte Neva Hot Springs, Ripley & Barneby No. 6292. UTAH. Central Utah, Parry No. 25 (NY). *Cache Co.:* Logan Canyon, Muenscher & Maguire No. 2376 (W). *Juab Co.:* Juab, Goodding No. 1090 (NY, PO). *Salt Lake Co.:* Salt Lake Valley, Jones in 1880 (PO, lectotype of *A. uintensis*). *Sanpete Co.:* Manti, Vansell in 1940 (CAS). *Summitt Co.:* NE. of Castle Rock, Ripley & Barneby No. 7827 (CAS). *Tooele Co.:* Deep Creek, Jones in 1891 (G, PO). *Utah Co.:* Thistle, Jones in 1898 (PO). *Wasatch Co.:* Park City, Jones in 1887 (PO). Hot Springs near Midway, Eastwood & Howell No. 496 (CAS, PO). WYOMING. sine loc., Parry, NW. Wyo. Exped. No. 79 (G). *Fremont Co.:* South Pass, Wind River Mts., Ripley & Barneby No. 7954. *Teton Co.:* Camp Davis, Wehmeyer & al. No. 5069 (G). *Uinta Co.:* Fort Bridger, Porter in Hayden's Surv. (G), A. Nelson No. 4678 (PO).

Astragalus argophyllus, originally published from Nuttall's notes, was almost at once, in the supplement to Torrey & Gray's Flora,[5] reduced to *A. glareosus*, and passed under that name for sixty years. When Jones began to meet with it in the field, he at first referred it to *A. Chamaeleuce*, but at length, suspecting an error, proposed for it the provisional epithet *uintensis*. This name, which was subsequently taken up and validated (sub *Xylophaco*) by Rydberg, was based on Jones' description of *"A. Chamaeleuce"* in Zoë 3:294. 1893, but no type was ever specified. Since the geographic implications of the name suggest that *A. uintensis* might in reality belong to var. *pephragmenoides* described below, it has been necessary to determine the exact concept Jones had in mind. In his herbarium there are several collections of *A. argophyllus* collected prior to 1893, but of these only two bear the name *uintensis* in Jones' hand: Salt Lake Valley, Jones in 1880, and Palisade, Nevada, Jones

5 Torrey & Gray followed Hooker & Arnott in this disposition.

No. 3833. The slightly earlier gathering from Utah seems to be the logical choice of lectotype, even though it did not originate in the Uintah Mts. This is precisely Nuttall's plant, the lowland, mesophytic race with large, purple flower. It should be noted that Jones himself, after seeing authentic *A. argophyllus,* reduced *A. uintensis* to it (cf. Cont. W. Bot. 8:5. 1898).

Of the varieties named by Jones in the Revision of Astragalus, the var. *Martini* seems to be no more than a dwarf form with short stems, leaves and pods, such as occurs here and there throughout the range of var. *typicus;* but the var. *cnicensis* is more puzzling, and should perhaps be maintained. The type (Thistle, Utah, Jones, June 5, 1901, PO) differs from the prevailing form in being greenish throughout, and having conspicuously persistent petioles. The pod is here nearly typical, but in another, otherwise similar, gathering from the same locality (Jones in 1898, PO), the fruit is remarkable in being narrowly lanceolate, 3.5 cm. long and about 7 mm. broad. Neither of these collections is in flower, so that it is difficult to arrive at a conclusion as to their proper status. Since typical *A. argophyllus* is known from several localities in the immediate neighborhood, it is perhaps not more than an occasional aberrant form.

Rydberg's *Xylophacos argophyllus* is almost precisely the var. *typicus* as here understood. But a specimen cited in his Revision of *Xylophacos* (Bull. Torr. Bot. Cl. **52**:156) from southern Utah (Jones No. 5163h) is *A. amphioxys,* and another, from Monticello, Utah (Rydberg & Garrett No. 9153) belongs to *A. missouriensis* var. *amphibolus;* in both the pubescence is of the dolabriform type.

The typical race of *A. argophyllus* is unique among the *Argophylli* in that it is apparently confined to moist, alkaline bottom lands; its xerophytic counterpart may be separated as

10b. var. **pephragmenoides,** var. nov.

A. Purshii x *argophyllus* Jones, Rev. Astrag. 207, Pl. 47. 1923.

A. Booneanus A. Nels., Bot. Gaz. **53**:223. 1912, pro parte.

A. argophyllus sensu A. Nels., Erythea **6**:53. 1898; non Nutt.

A var. *typico* corollae minoris dilute purpurascentis carina 13-17 mm. tantum longa, pube minus appressa e pilis saepissime patulis vel incumbentibus majori pro parte constituta, necnon radice graciliori absimilis. Ab *A. tephrodis* Gray var. *brachylobi* (Gray) nob. forma sericea (*A. pephragmeno* Jones) imprimis petalis haud subaequilongis pedunculisque folio superatis separatur.

Root relatively slender, the crown often divided into a suffruticulose caudex; pubescence of the herbage composed of more sinuous, loosely spreading, ascending or incumbent hairs; leaflets inclined to be crowded, narrowly obovate and less sharply acute; calyx hirsute or hirsutulous; corolla whitish, but the petals more or less suffused with purple towards the tips; banner 17-20 mm., keel 13-17 mm. long; pod shortly and thinly (or even copiously) villous-hirsute with curved hairs, or, in some forms transitional to var. *typicus,* strigose.

Type.—In sagebrush, on the north slope of Grand Mesa, Mesa Co., Colorado, Ripley & Barneby No. 5437 (Herb. Calif. Acad. Sci. No. 328030).

Distribution.—Hillsides and sagebrush mesas, in dry soil, from southern Idaho in the valley of the Snake River southward to the Wasatch Plateau, Utah, and thence east along the Uintas to western Colorado; apparently also on the Kaibab Plateau, Arizona.

Exsiccata.—ARIZONA. *Coconino Co.:* Nagle's Ranch, Jones No. 6054h (PO). COLORADO. *Mesa Co.:* Grand Mesa, Ripley & Barneby No. 5437 (CAS, type, NY). *Moffatt Co.:* W. rim of Lodore Canyon, C. L. Porter No. 3660 (RM). IDAHO. *Clark Co.:* Camas Meadows, Davis No. 357 (Poc). *Franklin Co.:* NE. of Mink Creek, Christ No. 14170 (NY). UTAH. *Carbon Co.:* Scofield, Jones in 1904 (PO). Miller Creek, Jones in 1910 (PO). *Duchesne Co.:* Uintah River, N. of Neola, Ripley & Barneby No. 4653. *Sevier Co.:* Salina Canyon, Jones No. 5428 (PO, cotype of *A. argophyllus* x *Purshii*, NY). SE. of Glenwood, Ripley & Barneby No. 4771 (CAS). *Summit Co.:* Castle Rock, No. 7819 (CAS). *Wasatch Co.:* Strawberry Reservoir, No. 4653. WYOMING. *Uinta Co.:* Evanston, A. Nelson No. 2990 (G, PO). Bear River, near Utah line, Payson & Payson No. 4813 (NY, PO). S. of Mountain View, Rollins & Gates No. 2368 (NY). *Sweetwater* (?) *Co.:* Leckie, Merrill & Wilcox No. 583 (G).

The proposed variety was regarded by Jones as a hybrid between *A. argophyllus* and *A. Purshii*, and it is in some degree intermediate, combining the sparsely pubescent (and not floccose-tomentose) pod of the former with a paler flower and more spreading vesture which could have been derived from the latter. But if this is the case, it becomes difficult to explain the apparent absence of *A. Purshii* from the Wasatch Plateau, where var. *pephragmenoides* is common, the absence of both supposed parents toward the "hybrid's" logical and continuous range, or the occurrence of both in close proximity throughout northern Nevada without a suspicion of crossing.[6] In nature var. *pephragmenoides* forms colonies of like individuals, disassociated from the supposed parents, and fails to exhibit the variability which might be expected in a hybrid swarm. The evidence all points to its having arisen as a mutant from *A. argophyllus* var. *typicus*, or vice versa; certainly the two are closely related, and there is no single character which separates them absolutely. The type of the variety, with its thinly villous pod, is the extreme form, but several intermediate specimens have been seen. In a cotype of *A. argophyllus* x *Purshii*, Jones' gathering from Miller Creek, Utah, the vesture of the leaves is spreading, but that of the pod is appressed. The same is true of Payson & Payson No. 4813 from the Uinta Mts., while in A. Nelson No. 2990 from Evanston the loosely pubescent calyx of var. *pephragmenoides* is apparently combined with the bright purple corolla of var. *typicus*. Porter's specimen from Moffatt Co., Colorado, bears an exceptionally pubescent pod, a fact that suggests that the *A. inflexus* of Graham (Ann. Carn. Mus. 26:248. 1937) from the same region, not seen by me, may in reality belong here. It remains a

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6 Jones cited as *A. argophyllus* x *Purshii*, a specimen (his No. 6450h) from northern Arizona, a locality several hundred miles south of the then (or now) known limit of *A. Purshii*, but he expressed no surprise at the spontaneous materialization of a hybrid in this remote locality. The material is meager, in fruit only, and although I have referred it to var. *pephragmenoides*, the determination remains doubtful. Conceivably the plant represents a form of *A. tephrodes* var. *brachylobus* with unusually short peduncles. The point must await further collections from the Kaibab Plateau.

possibility that the variety represents no more than a sporadic adaptation of the typical race to a xerophytic habitat, but until this can be proved experimentally, and despite admitted intergradation, it seems preferable for the present to recognize the observed differences systematically.

11. ASTRAGALUS PANGUICENSIS (Jones) Jones

Astragalus panguicensis (Jones) Jones, Cont. W. Bot. **10**:62, tab. 4. 1902; Barneby, Proc. Calif. Acad. Sci. IV, **25**:149. 1944. *A. Chamaeleuce* Gray var. *panguicensis* Jones, op. cit. II, **5**:671. 1895. *A. argophyllus* Nutt. var. *panguicensis* (Jones) Jones, Cont. W. Bot. **8**:5. 1898; Rev. Astrag. 207, Pl. 47. 1923.

Batidophaca sabinarum Rydb., N. Amer. Fl. **24**:320. 1929. *Astragalus sabinarum* (Rydb.) Barneby, Proc. Calif. Acad. Sci. IV, **25**:150. 1944.

Subacaulescent and densely tufted or with several developed, prostrate stems up to 5 (10) cm. long rising from the divisions of a branched, suffrutescent caudex; stems and herbage densely sericeous with appressed and ascending, rather fine, straight, shining, basifixed hairs; stipules loosely imbricated or at length discrete, ovate-acuminate, 2-4 mm. long; leaves ascending, 1.5-5 (8) cm. long, the slender, deciduous or feebly persistent petioles about equalling the rachis; leaflets 7-15 (17), ovate to elliptic, acutish to obtuse, 2-8 mm. long, equally sericeous on both faces; peduncles shorter than or equalling the leaf, arcuate-reclinate in fruit; racemes loosely (3) 6-8-flowered, 1 cm. long or less in fruit; calyx ascending-pilose with light or some dark hairs, the cylindric tube 5-7 mm., the subulate teeth 2.5-3 mm. long; corolla ochroleucous, the wings and keel tipped with dull purple, the narrow banner 14-16 mm., the wings 13.5-14.5 mm., the keel 12 mm. long; pod lance-acuminate, obtuse at base, arcuate throughout, 1.5-2.5 cm. long, 5-6 mm. in greatest diameter, obcompressed except in the narrowly triangular, laterally compressed beak, sulcate along the dorsal or often along both sutures, the valves leathery, reticulate, densely sericeous with appressed, strigose hairs; mature seeds not seen.

Type-locality.—Panguitch Lake, Utah; collected by M. E. Jones in 1894.

Distribution.—In open yellow pine forest in the mountains about the head of the Sevier River in southern Utah.

Exsiccata.—UTAH. *Garfield Co.:* Panguitch Lake, Jones No. 6023f (PO, cotype of *A. Chamaeleuce* var. *panguicensis*). Cow Puncher Creek, Aquarius Plateau, Maguire No. 19184 (W). Bryce Canyon, Eastwood & Howell No. 691 (CAS). *Iron Co.:* Cedar Canyon, Garrett No. R2660 (NY, type of *Batidophaca sabinarum*). *Kane Co.:* W. of Alton, Ripley & Barneby No. 4822 (CAS).

Astragalus Chamaeleuce var. *panguicensis* was based on two specimens collected by Jones in early September. The first mentioned by Jones is apparently not represented at Pomona, and has not been found elsewhere; the other, an autumnal fragment without pods surely belonging to it, has been the subject of a recent note (cf. Barneby, 1944, l. c.). The species is evidently a near ally of *A. argophyllus*, differing especially in its small flowers and narrow, arcuate pod. From *A. castaneaeformis*, which it resembles in habit and habitat, it is quickly distinguished by its pubescence of basifixed hairs. Rydberg, who apparently saw no authentic material, referred the name to the synonymy of *Xylophacos vespertinus* (cf. Bull. Torr. Bot. Cl. **52**:229. 1925), a variety of the entirely different *A. amphioxys*.

It is somewhat embarrassing to recall that in the very paper in which I discussed some aspects of *A. panguicensis* I also transferred *Batidophaca sabinarum* to *Astragalus* with the accolade "clearly . . . a good species." That I stood in greater awe of Rydberg's sagacity than I do today may be explanatory but is no excuse for adding another useless binomial to the immense synonymy of the genus. The type of *B. sabinarum* is in advanced fruit, and the fissured calyx, expanded and spread out around the base of the pod, appears to have been campanulate. As a *Batidophaca*, with campanulate calyx and (presumably; the flower is lacking) shortly clawed petals, *A. sabinarum* appeared fully distinct. It is now realized that appearances were deceptive, and that there is nothing in Garrett's specimens from the western slope of the Parowan Range which does not agree with our material of *A. panguicensis* from the headwaters of the Sevier immediately to the east.

12. ASTRAGALUS TEPHRODES Gray

Subacaulescent, the leaves and scapiform peduncles tufted on the multicipital root-crown, or with several prostrate stems up to 12 cm. long rising directly from the taproot or from the woody divisions of a shortly branched caudex; pubescence of the herbage and calyx basifixed, very variable in quality, density and distribution, either appressed-silky, thinly strigose with straight or incumbent hairs, villous, hirsutulous or shortly pilose; stipules loosely imbricated to shortly discrete, ovate-deltoid, acute, shortly acuminate or sometimes obtuse, 3-10 mm. long, at first herbaceous with scarious margins, at length scarious throughout; leaves spreading, 5-15 (20) cm. long, the deciduous petioles equalling or somewhat shorter than the rachis; leaflets 11-35, narrowly elliptic or obovate to broadly oblong or obovate, acute, obtuse or emarginate, commonly bicolored and brighter green (even when pubescent) above, (2) 4-15 (20) mm. long, either equally pubescent on both faces or variously glabrescent (particularly along the midrib) to quite glabrous above, and then often with a prominently white-ciliate margin; peduncles (4.5) 7-25 (40) cm. long, equalling or far surpassing (very rarely shorter than) the leaves, rather stout, reclinate and commonly arcuate in age; racemes (3) 8-15 (17) -flowered, rather loose, (1.5) 3-10 (15) cm. long in fruit; calyx-tube deeply campanulate to cylindric, 3.5-10 mm. long, the subulate to deltoid teeth 1-2.5 (3.5) mm. long; corolla rather dull purple, the claws pale, the extremities of the petals all more deeply colored; petals not strongly graduated, the keel usually not more than 2 mm. shorter than the broad, little retroarcuate banner; pod obliquely ovoid, lance-ovoid or oblong, very obtuse or truncate at base, nearly straight to arcuate through half a circle, obcompressed through the lower half or three quarters and thence passing into a shortly triangular or triangular-acuminate, laterally compressed beak, 1-4 cm. long and one half to one quarter as broad, the valves coriaceous to strongly woody, strigose-canescent with either straight or incumbent hairs, or rarely hirsutulous, villosulous or glabrate; seeds olive- or mahogany-brown, nearly smooth, often pitted, sometimes spotted with purple, (2) 2.3-3 mm. long.

Astragalus tephrodes, in the inclusive sense adopted here, is the southern counterpart of the Great Basin *A. argophyllus*, to which the form and texture

of the pod ally it closely. Separable from *A. argophyllus,* as a rule, by its longer, coarser peduncles, and by a tendency to glabrescence on the upper side of the usually bicolored leaflets, there are phases of it in which both these characters fail. A densely pubescent form, which has been described as *A. pephragmenus,* can be as silvery as typical *argophyllus,* and in depauperate individuals the raceme may be surpassed by the leaves. The exceptional cases in which both criteria are invalidated are still separable from *A. argophyllus* by their distinctive flower with but slightly graduated petals, by their looser fruiting racemes, and by their southern occurrence, while every representative collection from a given station shows some passage towards the diagnostic characters.

The species is not only highly polymorphic, embracing numerous minor races, and plastic in relation to its environment, but also quite variable within the compass of a single population, and it is uncommon to find two individuals quite alike in stature, size of flower and pod, and in pubescence. Several specific names have been applied to aspects of the species, and it would be convenient to maintain these superficially disparate plants as at least infraspecific entities; but all attempts to segregate the extant material into anything like definable morphological or geographic races have proved abortive. On the basis of vesture it is possible to classify several forms; at first thought the green and strigose *"chloridae,"* the crisply villous *"lenophyllus,"* the appressed-silky *tephrodes* proper, and the hirsute-villous *"pephragmenus"* appear readily distinguishable. The types of pubescence, however, not only pass one into another through a series of intermediate states, but also occur in plants with large and small flowers, with few or many leaflets, with longer or shorter pods, and promiscuously here and there almost throughout the species-range. In general there is a progression westwards from the relatively slender, small-flowered, sericeous *tephrodes* with leathery pods prevalent in southern New Mexico and adjacent Texas, through insensibly intergradient phases to the giant, large-flowered strigose extreme with woody pods of northwestern Arizona (*A. chloridae*) and a similarly robust but canescent plant in southern Nevada. A line of division between an eastern and a western variety, as attempted below, is arbitrary, and the geographic segregation is incomplete. Despite its imperfections and possible over-simplification, the present arrangement is thought to be the most realistic and useful solution of a perplexing problem. An alternative treatment, in which the criteria employed to distinguish the already named segregates of the *tephrodes* alliance are considered significant, would call for the description of at least half a dozen minor forms.

KEY TO THE VARIETIES OF A. TEPHRODES

Flowers relatively small, the calyx-tube (3.5) 4.5-7 (8) mm. long, the banner 11-17 mm., the keel 10-14 (15) mm. long; leaflets commonly conduplicate, always glabrescent above, at least along the midrib; pod relatively short, 1.5 cm. long or less, or, if longer, not more than leathery, the valves not rigid when dry; plants of western Texas to central New Mexico, northern Sonora and occasional in Arizona ..... var. *typicus*

Flowers relatively large, the calyx-tube (7) 8-9 (10) mm. long, the banner 17-22 mm., the keel (14) 16-19 mm. long; leaflets flat, either glabrous or pubescent

above; pod commonly longer, over 1.5 cm. long, the valves woody and rigid when dry; plants of southeastern, central and northwestern Arizona to adjacent New Mexico, Utah and Nevada ..... var. *brachylobus*

12a. var. typicus, nom. nov.

Astragalus tephrodes Gray var. *typicus* Barneby, nom. nov. *A. tephrodes* Gray, Pl. Wright. **2**:45. 1853; Proc. Amer. Acad. **6**:222. 1863; Torr., Bot. Mex. Bound. Surv. 56. 1859; Woot. & Standl., Cont. U. S. Nat. Herb. **19**:369. 1915; Jones, Rev. Astrag. 205, Pl. 48, 49. 1923; Tidestr. & Kitt., Fl. Ariz. & N. Mex. 202. 1941. *Tragacantha tephrodes* (Gray). O. Kze., Rev. Gen. 948. 1891. *Xylophacos tephrodes* (Gray) Rydb., Bull. Torr. Bot. Cl. **52**:156. 1925; N. Amer. Fl. **24**:298. 1929.

A. glareosus sensu Torr., Bot. Mex. Bound. Surv. 56. 1859; Hemsl., Biol. Centr.-Amer., Bot. **1**:264. 1880; non Dougl.

A. remulcus sensu Woot. & Standl., Cont. U. S. Nat. Herb. **19**:369. 1915; Jones, Cont. W. Bot. **17**:27. 1930, quoad pl. cit.; non Jones, alibi.

Pubescence strigose-sericeous or villosulous, the hairs straight, incurved or sinuous; leaflets 11-31, usually small, 1 cm. long or less, more or less conduplicate, glabrous above or with a glabrescent area along the midrib; peduncles 4.5-10 (15) cm. long; racemes in fruit 1.5-5 cm. long; calyx silky-strigose, sometimes loosely so or villosulous, the tube (3.5) 4.5-7 (8) mm. long; banner 11-17 mm., wings 13-16 mm., keel 10-14 (15) mm. long; pod ovoid-oblong, usually less than 1.5 cm. long, the valves thin-leathery (when sometimes up to 2.3 cm. long) or woody (when small), loosely strigose-canescent to glabrate.

Type-locality.—Plains at the base of the Organ Mountains, New Mexico; collected by Charles Wright in April, 1852.

Distribution.—Dry gravelly hillsides and clearings in open pinewoods, southern and central New Mexico, adjacent Texas (? and Sonora), and occasional westward to central Arizona.

Exsiccata.—ARIZONA. *Greenlee Co.:* Clifton, Rusby in 1881 (G). *Yavapai Co.:* Fort Verde, Dr. Mearns No. 345 (NY). Fort Verde Valley, W. W. Jones No. 43 (G). Seligman, Eastwood No. 5935 (CAS). NEW MEXICO. *Catron Co.:* Beaverhead, Eggleston No. 20389 (G). *Doña Ana Co.:* "Base of the Organ Mts.", Wright in 1852 (G, type). Organ Mts., Wooton in 1891 (PO), in 1893 (NY), No. 9 (M, in part, mixed with *A. sonorae* Gray), No. 10 (M). *Grant Co.:* Silver City, Eggleston No. 19947 (NY), No. 19952 (NY), No. 19953 (G, NY), No. 19955 (NY), Jones No. 26182 (CAS, G, PO), Ripley & Barneby No. 3043. Mimbres, Mex. Bound. Surv. No. 265 (NY), Thurber No. 198 (G), Eggleston No. 16371 (NY). Mangas Springs, Rusby No. 90½ (G, NY, PO). W. of Tyrone, Cory No. 3092 (G). *San Miguel Co.:* Kingman, Vasey in 1881 (G). *Santa Fe* (or *Bernalillo*) *Co.:* Between Albuquerque and Los Cerrillos, McKelvey No. 2373 (G). *Socorro Co.:* Socorro, Vasey in 1881 (G). West fork, Gila River, Eggleston No. 16065 (NY). Gila Forest, No. 16955 (NY). Black Canyon, No. 17001 (NY). SONORA. Guadelupe Pass (fide Torr., Bot. Mex. Bound. l. c.). TEXAS. *Hudspeth* (or *El Paso*?) *Co.:* Hueco Mts., Thurber No. 142 (G), 144 (G, in part).

The type of *A. tephrodes* is fragmentary and depauperate, with especially small flowers and pods, but it is unquestionably conspecific with Wooton's more robust topotypes and with the Thurber collection cited in the Mexican Boundary Survey. The pod, in the type, is rather thin-walled, the vesture of

the herbage and calyx loosely sericeous, and the leafflets 15-19, small, obtuse, conduplicate, bicolored and glabrescent along the midrib above. The collections which match it precisely are few. The copious material from Silver City, New Mexico, is variable in flower-size, ranging from nearly as small as in Wright's original gathering to nearly as large as in var. *brachylobus;* and the pods, though still short, are of a more woody texture. Nearby, in the Burro Mountains, occurs a plant (Cory No. 3092) otherwise similar, but with a thin-walled pod up to 2.3 cm. long. In Eggleston No. 20389, also with small flowers and pods, the leaflets are 23-31 to the leaf, glabrous above and conspicuously white-ciliate. Without further examples it will be seen that var. *typicus* is a remarkably inconstant entity. In attempting to extricate it from the more robust western phases of the species, I have referred to it all plants with either thin-walled pod (irrespective of size) or small pod (irrespective of texture) where found in combination with small flowers and small, conduplicate leaflets. The occurrence in western Arizona, in the heartland of var. *brachylobus,* of individuals with the required characters of var. *typicus* is puzzling, and gives weight to my suspicion that variation in *A. tephrodes,* however great it may be, is as well explained by edaphic response as by genetic instability. One specimen from this area (Eastwood No. 5935) is remarkable for its close resemblance in vesture, stature and habit to strictly typical *tephrodes,* but its pod is woody, with strong sutures and virtually glabrous valves, precisely similar, on a reduced scale, to that of the type of *A. remulcus* which, on account of its flat leaflets and longer corolla, is here reduced to var. *brachylobus*. While I feel that my definition of var. *typicus* is justified on grounds of convenience, I doubt that it is a truly natural entity.

Astragalus tephrodes has up till now been almost confined to the type-collection. Both Rydberg and Jones made much of the texture of the pod, but since the thin-walled state is not constantly combined with any other morphological character, and moreover intergrades completely with the rigidly woody state, it cannot be considered diagnostic of a natural species. Much of the material here regarded as belonging to var. *typicus* was referred by Jones to his *A. remulcus,* and by Rydberg, whose understanding of relationships in this group was scarcely more than rudimentary, to *Xylophacos remulcus* (the Wooton topotype in NY, Eggleston No. 19953, etc.), *X. cyaneus* (Eggleston No. 17001, etc.), *X. brachylobus* (Eggleston No. 19953, 19955, etc.) and *X. pephragmenus* (Eggleston No. 19947, Mex. Bound. Surv. No. 260). This last from the Boundary Survey, named "*A. glareosus ?*" in Torrey's hand, lacks locality-data, but presumably is the Bigelow plant from "near the Copper Mines" mentioned by Torrey (l. c.) under that name. The dubious *A. glareosus* was also reported by Torrey from Guadelupe Pass, Sonora. No corresponding specimen has been seen, but the occurrence of *A. tephrodes* in the mountains south of the New Mexican border is extremely probable.

12b. var. **brachylobus** (Gray), comb. nov.

Astragalus tephrodes Gray var. *brachylobus* (Gray) Barneby, comb. nov. *A. Shortianus* Nutt. var. *brachylobus* Gray, Proc. Amer. Acad. **13**:367. 1878. *A. amphioxys* var. *brachylobus* Gray ex Jones, Rev. Astrag., Index, in syn., nom nud. *Xylophacos*

brachylobus (Gray) Rydb., Bull. Torr. Bot. Cl. **52**:154. 1925, quoad basinym., exclus. typ. et descr. pro max. parte; N. Amer. Fl. **24**:297. 1929, quoad nomen; non *A. brachylobus* DC., 1825. *A. curtilobus* Tidestr., Proc. Biol. Soc. Wash. **48**:40. 1935, quoad basinym. *A. curtilobus* Tidestr., op. cit. **50**:20. 1937, quoad basinym.

A. pephragmenus Jones, Zoë **4**:267. 1893; Sheld., Minn. Bot. Stud. **1**:146. 1894; Tidestr. & Kitt., Fl. Ariz. & N. Mex. 201. 1941; Kearn. & Peeb., Fl. Pl. Ariz. 478. 1942. *A. argophyllus* Nutt. var. *pephragmenus* (Jones) Jones, Rev. Astrag. 208, Pl. 47. 1923. *Xylaphacos pephragmenus* (Jones) Rydb., Bull. Torr. Bot. Cl. **52**:151. 1925, pro max. parte; N. Amer. Fl. **24**:295. 1929.

A. remulcus Jones, Proc. Calif. Acad. Sci. II, **5**:658. 1895; Rev. Astrag. 209, Pl. 48. 1923; Tidestr. & Kitt., Fl. Ariz. & N. Mex. 201. 1941; Kearn. & Peeb., Fl. Pl. Ariz. 479. 1942. *Xylophacos remulcus* (Jones) Rydb., Bull. Torr. Bot. Cl. **52**:153. 1925; N. Amer. Fl. **24**:296. 1929.

A. intermedius Jones, Proc. Calif. Acad. Sci. II, **5**:656. 1895, pro parte; non *A. intermedius* Kar. & Kir. *A. Phoenicis* Jones,[7] *Cont.* W. Bot. **8**:12. 1898; Rev. Astrag. 232, exclus. Pl. 59. 1923.

Xylophacos lenophyllus Rydb., Fl.. Rocky Mts., ed. 2, 1126. 1922.

Astragalus remulcus var. chloridae Jones (as *Chloridae*), Rev. Astrag. 210, Pl. 48. 1923. *Xylophacos chloridae* (Jones) Rydb., Bull. Torr. Bot. Cl. **52**:153. 1925; N. Amer. Fl. **24**:296. 1929. *Astragalus chloridae* (Jones) Tidestr., Proc. Biol. Soc. Wash. **48**:40. 1935. *A. chloridae* (Jones) Tidestr., op. cit. **50**:20. 1937; Tidestr. & Kitt., Fl. Ariz. & N. Mex. 201. 1941; Kearn. & Peeb., Fl. Pl. Ariz. 479. 1942.

Pubescence sparse or copious, the herbage thus green to densely canescent, the hairs (in either case) straight and appressed, or spreading, incumbent or villosulous; leaflets 11-35, flat (very rarely conduplicate in youth), (2) 5-20 mm. long, obtuse or acute, equally pubescent on both faces or glabrous to glabrescent above; peduncles (4.5) 10-40 cm. long; racemes in fruit (1.5) 4-15 cm. long; calyx strigose to villous, sometimes with dark hairs, the tube (7) 8-9 (10) mm. long; banner 17-22 mm., wings 16-20.5 mm., keel (14) 16-19 (20) mm. long; pod ovoid, ovoid-lanceolate or oblong. 1.5-4 cm. long, nearly straight to arcuate through half a circle, with both sutures very thick and prominent, the woody valves shortly hirsute, villosulous, strigose, strigulose or glabrate, sometimes narrowly inflexed dorsally as an obscure partition less than 1 mm. high.

Type-locality.—"Arizona," actually Prescott and Cottonwood, Yavapai Co.[8]; collected by Edward Palmer in 1876.

Distribution,—Desert mountains, in oak-brush or in xeric pine-forest, Sonoran to Arid Transition, southeastern Nevada and southern Utah, where very rare, and across Arizona from Mohave County southeastward, chiefly along the Mogollon Plateau, to southwestern New Mexico.

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7 Possibly this name refers to Phoenix, Arizona, in which case it should be decapitalized.

8 For information as to the whereabouts of Cottonwood I am indebted to Dr. T. H. Kearney who informs me (in litt.) that the locality is in the Verde River valley near Clarkdale.

Exsiccata (*selecta*).—ARIZONA. *Coconino Co.:* Grand Canyon, MacDougal No. 199 (G, in part, NY, PO). Flagstaff, No. 27 (NY, type of *X. lenophyllus*, G, PO). Cosnino, Ripley & Barneby No. 5236 (CAS, NY). SW. of Frazier's Wells, No. 5224. *Gila Co.:* Crest of Pinals on road to Tonto Basin, Jones in 1890 (PO, type of *A. pephragmenus*, G). Alder Creek, Mazatzal Mts., A. & R. Nelson No. 1959 (G, NY). Oxbow Hill, Eastwood No. 17516 (CAS). Sierra Ancha, 15 miles N. of Salt River bridge, Peebles & Smith No. 13261 (NY). 21 miles from Globe, on Springerville Road, Foster & Arnold No. 257 (G). *Graham Co.:* Fry Creek, Mt. Graham, Eggleston No. 19904 (G, NY). *Greenlee Co.:* 36 miles N. of Clifton, Ripley & Barneby No. 3106. *Maricopa Co.:* Camp Creek to Ashdale, Peebles No. 11612 (CAS, PO). *Mohave Co.:* Chloride, Jones in 1903 (PO, type of *A. remulcus* var. *chloridae*, G, NY), Ripley & Barneby No. 3377 (CAS). Cerbat Mts., Lemmon No. 3354 (G). Hualpai Mt., Jones in 1903 (PO). *Navajo Co.:* Showlow, Foster & Arnold No. 287 (G). *Yavapai Co.:* Prescott, Palmer No. 102 in 1876 (G, cotype of *A. Shortianus* var. *brachylobus*, NY), Eastwood No. 8830 (CAS). Cottonwood, Palmer No. 115 in 1876 (G, cotype of var. *brachylobus*, NY). Banghart's Ranch, Rusby No. 576 (NY, isotype of *A. remulcus*). Skull Valley, Jones in 1903 (NY, PO). NEVADA. *Lincoln Co.:* Needle Mts., NE. of Caliente, Ripley & Barneby No. 6359 (CAS, G, NY), No. 6416 (CAS). NEW MEXICO. *Grant Co.:* Fort Bayard watershed, Blumer No. 167 (NY). UTAH. *Washington Co.:* Springdale, Jones in 1894 (PO).

The two collections from which Gray drew the original character of *A. Shortianus* var. *brachylobus* are fortunately representative of the commonest phase of their species, that prevailing throughout the mountains of central and northwestern Arizona. Here the pubescence is appressed, and composed of nearly straight hairs, but the ample material also demonstrates the characteristic variability of its kind in other directions, and includes plants with relatively short and much elongated peduncles (up to 2.5 dm. long), and with leaflets either glabrous or canescent-strigose above. The long-peduncled individuals closely approach the giant *A. remulcus* var. *chloridae*, known in exactly typical form only from the Cerbat Mts. in northwestern Arizona. The type of the latter is distinguished by its robust habit, green and sparingly strigose herbage, stout pednucles, loose racemes, partially dark-hairy calyx with relatively long teeth and strongly arcuate legume. But in topotypes collected by Ripley and the writer most of these characters are obscured; the calyx-teeth are no longer than in var. *brachylobus*, the peduncles and racemes no longer, and the vesture quite as copious. Elsewhere in the region the critical characters of *chloridae* are combined in various ways with those of true *brachylobus*, so that it seems impossible to regard it as more than the extreme state in a sequence of variation. Inconstancy in the length of peduncle and in the distribution of vesture occurs so generally in *A. tephrodes*, that it may be regarded as characteristic of the species. Often the lower leaves will be glabrous above, while the upper are pubescent; or the two states will be found in plants growing side by side, the peduncles being in either case long or short.

The most perplexing variation in *A. tephrodes* var. *brachylobus* is encountered in the quality of the pubescence, elsewhere in the *Argophylli* and generally throughout the genus a reliable and pretty constant specific character. Here, apart from their quantity, distribution or, on the calyx, color, the hairs fluctuate in length, orientation and texture to a quite remarkable degree. They may be straight and appressed, straight and loosely ascending, incurved, sinuous or spreading and curly. Some of these conditions correspond with named entities, others are nameless, but all pass one into another by gradual blurring

of their distinctive facies. In the state known as *A. pephragmenus* the herbage is densely silvery-hirsute with ascending, straightish hairs and the pods are shortly villous-hirsute. But even in part of the type of this (G) the leaflets are glabrescent above, in other similar material the pod is merely strigose, and in either the calyx may be either shaggy with soft, dark villi or white silky-strigose. In another extreme, which more or less agrees with the type of *Xylophacos lenophyllus,* both the leaves and pods are villous with fine, tangled and curly hairs. In the Nevadan plant, which in stature approaches *chloridae* (except for its yet larger pod), the vesture is silky, appressed but somewhat tangled. Occasionally, combined with the strigose herbage of *brachylobus,* the pod is nearly glabrous or truly so at maturity, thus becoming exactly *A. remulcus* Jones. From the evidence available these phases seem to be in no way segregated geographically. The state corresponding more or less closely with Palmer's original *brachylobus* is common along the foothills of the Mogollon Escarpment, and the silvery *pephragmenus* is occasional in the same range. The curly-villous *lenophyllus* is perhaps confined to the *ponderosa* pine-forests of the Mogollon Rim, but both the preceding occur also in that environment. Critical field-studies may yet uncover significant ecological factors which will assist in the definition of these and other races; but for the present a more elaborate classification than that proposed here seems unjustified.

The difficulties encountered in the *A. tephrodes* complex by former students of the genus is reflected in the synonymy and literature. The situation is puzzling enough of itself, and has been further involved by the persistence of avoidable errors. The identity of *A. Shortianus* var. *brachylobus,* the basinym of our *A. tephrodes* var. *brachylobus,* has been completely lost sight of in a series of misinterpretations. Gray's brief diagnosis, which immediately follows his extrication of *A. amphioxys* from *A. missouriensis* and *A. Shortianus,* reads: "A marked variety of it (var. *brachylobus,* recently collected by Dr. Palmer in Arizona) has a shorter pod with an obtuse apex." From the text it is not altogether clear to which species, whether *A. Shortianus* or *A. amphioxys,* Gray intended his variety to be subordinated, but any ambiguity is cleared up by the annotated type in the Gray Herbarium. Nevertheless Sheldon, without explanation and certainly without authority, adopted the combination "*A. amphioxys* var. *brachylobus* Gray," and used it freely in annotating specimens, whence it was taken up by Jones and referred by him to the synonymy of his own *A. remulcus.* Obviously it is a *nomen nudum.*

The identity of the type of var. *brachylobus* has also afforded opportunity for error. Rydberg, basing his *Xylophacos brachylobus* on Gray's variety, claimed (Bull. Torr. Bot. Cl. 52:154) that the latter was founded on Palmer's No. 102, collected in 1877, supposedly "the only specimens Dr. Gray had before him at the time." Among the exsiccata listed as *X. brachylobus* in the same paper Rydberg included, however, a Palmer collection from Arizona, his No. 115 collected in *1876,* which no doubt had already reached Gray at that time. In fact there are in the Gray Herbarium no less than three sheets actually named in Gray's hand "*A. Shortianus* var, *brachylobus,*" viz. Palmer No. 115 in 1876 (from Cottonwood, Ariz.), Palmer No. 102 (from Prescott, Ariz.),

and a third, unnumbered, which seems to contain a mixture of the surplus material which (after sharing the collections with Dr. Torrey) could not be mounted on the other two. There can be no question that these specimens, which represent the species here treated as *A. tephrodes* var. *brachylobus*, are those Gray had in mind. The No. 102 of Palmer's 1877 collection, which Rydberg claimed as the type of var. *brachylobus*, is also represented at Harvard, and is nothing more than an ordinary, if imperfect, specimen of *A. amphioxys*. There is no vestige of evidence that Gray considered this even conspecific, let alone typical, of his *A. Shortianus* var. *brachylobus*.

What then is *X. brachylobus* Rydb., which has entered the literature as *A. curtilobus* Tidestr? Since Rydberg's lectotype is merely a specimen of *A. amphioxys*, the name (excluding the basinymic element) becomes a synonym of that species, but his concept was clearly something else. Neither his choice of lectotype nor his description of *X. brachylobus* offers a certain clue to his intentions, but from the material cited in his revision of *Xylophacos* (1925) some hints may be gathered. *Xylophacos brachylobus* is no more than the name suggests, a *Xylophacos* with short calyx-lobes or, perhaps more exactly, *any Xylophacos* with short calyx-teeth. Among the collections referred by the author to his species is found an astonishing mixture of unrelated and dissimilar plants, either with dolabriform (e. g. Fendler No. 149, *A. missouriensis;* Palmer No. 102 in 1877, *A. amphioxys*) or basifixed pubescence (e. g. Palmer 115 in 1876, type of *brachylobus*) and even Jones' collection from the Pinal Mts., Arizona, the type-collection of a species, *A. pephragmenus*, which Rydberg himself recognized as distinct in the same paper. *Xylophacos brachylobus* was a chimera, both nomenclaturally and taxonomically, and the *A. curtilobus* based upon it must be suppressed. The latter name has been applied to a short-lived, small-fruited form of *A. amphioxys* (q. v. supra), which is not even precisely like the Palmer plant which Rydberg claimed as the type.

The remaining synonyms of var. *brachylobus* require little comment. *Astragalus remulcus* was recognized by Jones himself as being the equivalent of "*A. amphioxys* var. *brachylobus*," from which the type differs only in having an eventually glabrate pod. Contrary to Rydberg's claim (sub *X. remulco*), the legume is not truly glabrous, for in the isotype which I have seen a few scattered hairs are readily visible along the ventral suture. Nevertheless it seems to be a rare and unusual form. No other mature specimen with the pod as nearly glabrous has been examined, and all those so named by Rydberg in the New York Botanical Garden are (conveniently) in flower only. *Astragalus pephragmenus*, the canescent extreme discussed above, was reduced by Jones to a variety of *A. argophyllus*, which it resembles in vesture only, and not in general facies, shape of pod, or proportion of petals, all of which ally it firmly to the *tephrodes* group. *Astragalus intermedius*, a later homonym for which Jones later substituted *A. phoenicis*, is said by Rydberg (Bull. Torr. Bot. Cl. 52:151) to have been based on a mixture of *A. pephragmenus* collected also by Palmer in Arizona and some loose, bilocular pods of another species. I have not seen the type, in the National Herbarium, but since Jones

distributed under the name *A. phoenicis* his collection of *A. tephrodes* var. *brachylobus* from Skull Valley, it is likely that Rydberg was right. If not, and *A. phoenicis* is a distinct species, it would in any case be excluded, by the form of the legume, from the *Argophylli*.

13. **Astragalus iodopetalus** Greene, nom. nov.

Astragalus iodopetalus Greene. nom. nov.; Jones, Rev. Astrag., Index, 1923, in syn.: Rydb., Bull. Torr. Bot. Cl. **52**:152. 1925, in syn. *Xylophacos iodopetalus* (Greene) Rydb., l. c. 1925; N. Amer. Fl. **24**:296. 1929.

Xylophacos stipularis (Jones) Rydb., Fl. Rocky Mts. 504, 1063. 1917, pro max. parte; non *A. arietinus* var. *stipularis* Jones.

Astragalus jemensis A. Nels., Amer. Journ.. Bot. **21**:574. 1934, pro parte.

A. Shortianus sensu Jones, Rev. Astrag. 205. 1923, pro parte; non Nutt.

Caulescent, with numerous coarse green prostrate striate and sparsely hirsute-strigose stems radiating from the crown of a thick, multicipital taproot, forming circular matlike plants 1-3 dm. in diameter; herbage prevailingly green, but the leaves thinly (rarely canescently) hirsute-silky below with long hairs; stipules conspicuous, broadly ovate-acuminate, adnate to the petiole, pale green becoming membranous, many-nerved, sparsely hirsute and ciliate, 6-12 mm. long; leaves ample, (4) 9-18 cm. long, the wholly deciduous petioles 4-8 cm. long; leaflets 17-27, conspicuously diminishing up the rachis, obovate to oblanceolate, rounded at apex, 7-18 mm. long, thin, green, glabrous above or with a few hairs near the long-ciliate margin; racemes 14-25-flowered, dense at first, but elongating and in fruit 3-8 cm. long, on stout at length reclinate peduncles (4) 6-9 cm. long; calyx submembranous, loosely hirsutulous with white hairs, the tube 7.5-10 mm., the subulate teeth 3-4 mm. long; corolla reddish-violet, drying bluish, the banner 18-22 mm., the wings 16-20 mm., the keel 13-15 mm. long, the blades of the latter abruptly arcuate through a little more than a rightangle to the obtuse apex; pod obliquely ovoid, oblong or lance-oblong, obtuse at base, strongly obcompressed and but little arcuate except at the incurved, deltoid or deltoid-acuminate, compressed, proriform beak, 1.7-2.7 cm. long, 8-10 mm. broad and about 4 mm. high, both sutures, but especially the ventral, prominent and depressed-sulcate, sometimes so deeply as almost to divide the pod into two chambers, the dorsal also sometimes narrowly introverted and forming a partial septum 1 mm. or less deep, the valves green and fleshy becoming coriaceous, castaneous or straw-colored and about 1 mm. thick, glabrous, reticulate and somewhat rugose; seeds very dark brown, smooth and shining, 2-2.3 mm. long.

Type-locality.—Arboles, Colorado; collected by C. F. Baker in 1899.

Distribution.—Mountainsides and canyons, often among oak-brush, along the Gunnison and tributaries of the San Juan rivers in southwestern Colorado, and in adjacent New Mexico.

Exsiccata.—COLORADO. *Archuleta Co.:* Arboles, Baker No. 415 (NY, type, G). *Gunnison Co.:* Sapinero, No. 184 (G, NY). Cebolla, N. L. T. Nelson No. 23 (NY).

La Plata Co.: Durango, Ripley & Barneby No. 5341 (CAS, NY). *Montrose Co.:* Montrose, Payson No. 87 (G). NEW MEXICO. *Sandoval Co.:* Lower Jemez Canyon, Jemez Mts., E. F. Castetter No. 1190 (RM).

Astragalus iodopetalus is manifestly related both to *A. Shortianus,* to which Jones reduced it, and perhaps more closely to the *tephrodes* group, which it resembles in the bicolored leaflets, the reddish-violet color of the petals that turns bluish on drying, and in the general configuration of the pod. From all forms of the latter the combination of loosely pubescent calyx with long teeth, glabrous pod, and disjunct distribution satisfactorily distinguishes it; while the glabrescent or glabrous upper surface of the more numerous leaflets, strongly caulescent green stems, and thinner glabrous legume at once separate it from *A. Shortianus.*

Rydberg at one time identified this species with *A. arietinus* var. *stipularis* Jones (cf. *A. zionis,* infra) and, with *A. iodopetalus* in mind, published the combination *Xylophacos stipularis.* Later he rectified the error, but without reaching a conclusion as to the identity of var. *stipularis.* The single gathering known to me from New Mexico was cited by Nelson as part of his *A. jemensis,* being the element which seems to have suggested the specific epithet. The actual type of the latter belongs, however, to *A. Shortianus* var. *cyaneus* (q. v.). The species probably occurs elsewhere in northern New Mexico, and it is to be suspected that the *A. Shortianus* of Wooton & Standley (Cont. U. S. Nat. Herb. **19**:365. 1915) from Shiprock, San Juan Co., in reality belongs here.

The combination *A. iodopetalus,* having appeared in print merely as a synonym, and employed by Greene only in manuscript, is here validated apparently for the first time.

14. ASTRAGALUS ZIONIS Jones

Astragalus zionis Jones, Proc. Calif. Acad. Sci. II, **5**:652. 1895; Rev. Astrag. 208, Pl. 47, 78. 1923; Tidestr., Cont. U. S. Nat. Herb. **25**:328. 1925; Barneby, Proc. Calif. Acad. Sci. IV, **25**:149. 1944. *Xylophacos zionis* (Jones) Rydb., Fl. Rocky Mts. 504. 1917; Bull. Torr. Bot. Cl. **52**:148. 1925; N. Amer. Fl. **24**:293. 1929.

(?) *A. arietinus* Jones var. *stipularis* Jones, Proc. Calif. Acad. Sci. II, **5**:654. 1895. *A. stipularis* Jones, op. cit. 655, nomen provisorium. *Xylophacos stipularis* (Jones) Rydb., Fl. Rocky Mts. 504. 1917, quoad nomen, non descr.

Loosely or densely cespitose, but usually with developed, strigose to densely white-tomentose stems (1) 2-7 cm. long rising from the summit of a taproot or the divisions of a suffrutescent caudex; herbage greenish or strongly canescent, the pubescence basifixed, closely appressed and hirsute-strigose or loosely ascending and somewhat villous; stipules loosely imbricated or the upper discrete, deltoid, deltoid-acuminate or ovate, 3-6 mm. long, sometimes very broad and conspicuous, amplexicaul and appearing connate, thinly herbaceous becoming scarious, glabrate, pubescent or tomentose at first; leaves 3.5-15 (25) cm. long, the slender petioles 1.5-6 (13) cm. long, for the most part becoming rigid, wiry, arcuate-recurved and persistent on the caudex; leaflets (11) 13-23, usually rather distant, narrowly oval or lozenge-shaped to ovate or obovate,

acute or very rarely rounded at apex; racemes 3-11 (20) -flowered, loose, becoming (0.5) 1-5 (9) cm. long in fruit, on at length reclinate and more or less persistent peduncles (1.5) 3-8 (15) cm. long, either surpassing or surpassed by the subtending leaf; calyx villous with dark or light hairs in varying proportions (but the black usually perdominant), the tube (5) 6-10 mm., the subulate teeth 1.5-3.5 (5) mm. long; corolla purple, the banner 17-21 (23) mm., the wings 16-20 mm., the keel 14-17 (19) mm. long; pod ovoid to lanceovoid, obtuse or shortly acute and either laterally or dorsiventrally compressed at base, arcuate through half a circle or less into the abruptly or gently acuminate beak, 1.5-2.4 (3) cm. long, 5.5-9 mm. in greatest diameter, sulcate ventrally below the middle, dorsally above the middle or through its whole length, the ventral suture very prominent, the dorsal less so, the valves fleshy at first, becoming leathery, reticulate, loosely ascending-strigose to villosulous with scattered hairs, brightly mottled, sometimes narrowly infexed dorsally near the base as an obscure partial partition less than 1 mm. deep; seeds brown, shining but often pitted, 2-3 mm. long.

Type-locality.—Springdale, Utah, in red sand; collected by M. E. Jones in 1894.

Distribution.—On sandstone ledges or talus below cliffs, locally common along the Virgin and Kanab rivers in southern Utah, and along the Colorado and its tributaries from the Grand Canyon, Arizona, to southeastern Utah (?and adjacent Colorado).

Exsiccata.—ARIZONA. *Coconino Co.:* Mouth of Hermit Creek, Grand Canyon, Eastwood No. 5993 (CAS). Limestone Tanks, Ripley & Barneby No. 4868 (CAS, G). COLORADO. *Montezuma Co.:* McElmo Creek, Eastwood in 1892 (PO, type of *A. arietinus* var. *stipularis*). UTAH. *Kane Co.:* N. of Kanab, Ripley & Barneby No. 4854. Orderville, No. 4825. *San Juan Co.:* Bluff, No. 5371. *Washington Co.:* Springdale, Jones No. 5261w (PO, type), No. 5239 (NY, PO), 5249 (PO), 5249g (NY), Ripley & Barneby No. 4327 (CAS). Zion Canyon, Jones in 1923 (CAS, PO), in 1925 (NY, PO). Clear Creek Canyon, Eastwood & Howell No. 9229 (CAS, G, RB), Ripley & Barneby No. 4327. Rockville, Jones No. 5224d (PO).

Astragalus zionis, by reason of its loosely branched and slender caudex, small, elliptic and acute leaflets, densely black-villous calyx and relatively short, mottled legume, produces on the mind a strong impression of individuality, and it is therefore surprising to encounter difficulties in separating it from its allies. Specimens occur, however, which are densely cespitose and subacaulescent, with leaflets rounded at apex, or with vesture of the calyx entirely or largely composed of white hairs, and these are not readily distinguished from forms of *A. argophyllus* or *A. tephrodes.* The mottling of the pod, apparently diagnostic here though as a rule a poor character in the genus, has been used in the key as a criterion, but its shape, texture and compression, more easily perceived than described, form the more solid basis on which the validity of the species must rest. The legume shows the same latitude of variation as occurs in most of the *Argophylli,* being either strongly arcuate or nearly straight, but the valves are always fleshy, in drying becoming coriaceous but scarcely woody; as a rule the apex is abruptly narrowed into a deltoid,

laterally compressed beak, but may also be acuminate. The ventral suture is commonly depressed below the middle of the pod, and the dorsal above the middle, so that a longitudinal section through the sutural plane assumes, or tends to assume, a sigmoid outline.

Astragalus zionis is a characteristic element of the flora of Zion Park where, closely associated with the great sandstone cliffs cut by the passage of the Virgin River, it forms broad, loose mats in the crevices of the rock itself or smaller and somewhat denser tufts on the sandy talus at their foot, thence seeding down to the outwash flats of the valley floor. Material from this region is mostly relatively small-flowered, with calyx-tube 5-8 mm. and keel 14-16 mm. long, while the petioles and raches are inclined to be flaccid and but feebly persistent on the caudex branches. Plants from the canyons of the Colorado and San Juan rivers, otherwise similar, differ slightly in having larger flowers, with calyx-tube 9-10 mm. and keel 17.5-19 mm. long, and the more wiry petioles are very strongly persistent. Intergradation is considerable, and until more is known about this interesting race it seems wise not to separate it formally. Should it become desirable to do so, *A. arietinus* var. *stipularis*, which probably belongs to this form, will have to be considered with care. The type-material is fragmentary and perhaps mixed with *A. naturitensis* Pays., and I have been unable to identify it with assurance. Jones reduced his variety (Rev. Astrag., Index) to *A. desperatus* Jones, a species very similar to *A. naturitensis*, differing mainly in the strigose, and not hirsute, legume. But in both these the calyx is shortly campanulate and the pod of quite thin texture. In at least part of Miss Eastwood's original material of var. *stipularis* the calyx is long-cylindric and the (detached, and therefore not necessarily pertinent) pod is woody. The problem must await further collections from that remote and pathless corner of Colorado which Miss Eastwood alone seems to have penetrated in search of plants.

15. ASTRAGALUS COCCINEUS Bdg.

Astragalus coccineus Bdg., Zoë **2**:72. 1891; Sheld. ap. Cov., Cont. U. S. Nat. Herb. **4**:86. 1893; Minn. Bot. Stud. **1**:144. 1894; Jones, Rev. Astrag. 218, Pl. 52, 53. 1923. Tidestr., Cont. U. S. Nat. Herb. **25**:328. 1925; Jeps., Man. Calif. 573, fig. 563. 1925; Fl. Calif. **2**:359. 1936; Rowntree, New Fl. & Sylv. **4**:275. 1932; Munz, Man. S. Calif. 266. 1925; Ripley, Bull. Alp. Gard. Soc. **5**:238. 1937; op. cit. **10**:25. 1942, cum ic. photogr.; Jaeger, Desert Wildflrs. 122, fig. 263. 1940; Abrams, Ill. Fl. Pac. St. **2**:579, fig. 2812. 1944. Clokey, Madroño 6:215. 1942.

A. grandiflorus Wats., Proc. Amer. Acad. **17**:370. 1882; Davidson, Fl. S. Calif. 196. 1923; non *A. grandiflorus* L. 1753.

A. Purshii Dougl. var. *coccineus* Parry, W. Amer. Sci. **7**:10. 1890. *Xylophacos coccineus* (Parry) Heller, Muhlenb. **2**:317. 1906; Rydb., Bull. Torr. Bot. Cl. **52**:372. 1925; N. Amer. Fl. **24**:307. 1929.

Acaulescent, the thick crowns clustered on the summit of a stout, vertical taproot and clothed below (except in the first year of growth) with a dense thatch of persistent petioles and peduncles; herbage densely tomentose-canescent with loosely ascending or somewhat spreading and tangled hairs, subsericeous when young but becoming looser and more cottony with age; stipules closely imbricated, lanceolate, acute, 6-10 mm. long, white-pubescent, largely

or entirely concealed by the persistent petioles; leaves 3.5-10 cm. long, the stout petioles equalling or somewhat shorter than the rachis; leaflets 7-15, broadly oblanceolate, elliptic or obovate, obtuse or acutish, 5-13 mm. long, thick; racemes (3) 5-10-flowered, 1-2.5 cm. long in fruit, on very stout, at length reclinate, peduncles (2) 4-9 cm. long; calyx reddish, rather thinly long-villous, the tube 12-15 mm., the narrow, often nigrescent (as also the bracts and pedicels) teeth 3-6 mm. long; corolla scarlet, drying crimson, the oblanceolate, little arcuate banner and the keel subequal in length, 3.5-4 cm. long, the narrow straight wings about 2 mm. shorter, the keel straight, its blades oblanceolate, scarcely or not at all oblique, the apex triangular, subacute; pod obliquely lance-ovoid, acuminate, gently arcuate throughout, somewhat obcompressed except at apex, shallowly sulcate on both sutures, manifestly inflated, 2.5-4 cm. long, about 1 cm. in greatest diameter, the valves coriaceous, about 0.3 mm. thick when dry, reticulate, densely silky-villous and tomentose with spreading hairs 2-3 mm. long; seeds dark brown, 2.5 mm. long.

Type-locality.—Summit of the Inyo Range, California; collected by G. P. Rixford about 1890.

Distribution.—Gravel ridges and canyon-sides of mountains bordering the deserts of southern California, between 2100 and 7000 ft. altitude, from Owens Valley and the Death Valley region to the San Gabriel and San Bernardino ranges and southward, along the west side of the Colorado Desert, to the borders of Baja California; reported from southern Nevada.

Exsiccata (*selecta*).—CALIFORNIA. *Inyo Co.:* sine loc., Brandegee in 1891 (PO, perhaps from Lone Pine and cotype of *A. coccineus*). Silver Canyon near Laws, Heller No. 8190 (CAS, G). Black Canyon, White Mts., Duran No. 545 (CAS, G, NY). Inyo Mts., E. of Zurich, Ripley & Barneby, No. 5887 (CAS). Darwin, Jones in 1897 (NY, PO). Panamint Mts., Coville & Funston No. 491 (G, NY, P). *Kern Co.:* Red Rock, Mohave Desert, W. M. Pierce in 1922 (PO). *Los Angeles Co.:* Rock Creek, Mason No. 3044 (CAS, G, NY). *Riverside Co.:* Palm Springs, Johnston No. 1063 (PO). *San Bernardino Co.:* Desert slope of San Bernardino Mts., S. B. & W. F. Parish No. 1280 (G, type of *A. grandiflorus*). Cushenbury Canyon, Ripley & Barneby No. 4277. Quail Springs, Conchilla Range, Munz & Johnston No. 5221 (G, PO). *San Diego Co.:* Mountain Springs, Orcutt in 1890 (G, type-collection of *A. Purshii* var. *coccineus*). Jacumba to Mountain Springs, Eastwood No. 9517 (CAS, G, PO). Jacumba, Eggleston No. 19818 (CAS, G, NY, PO).

This magnificent species was first described as *A. grandiflorus* Wats., a combination long preoccupied in the genus by Linnaeus and Pallas. Subsequently Parry, on a different type, erected the var. *coccineus* of *A. Purshii;* and finally it attained specific rank as *A. coccineus* Bdg. Brandegee's proposition seems to have been quite independent, and not a transfer of Parry's varietal epithet. It is true that Brandegee mentioned the variety and supposed it to be synonymous with his species, but he cited and actually described two later gatherings, that of Rixford from the summit of the Inyo Mts., and his own from Lone Pine. It seems best, therefore, to regard Rixford's plant (probably in the herbarium of the University of California; not seen by me) as the type, and to accredit the species solely to Brandegee without parenthetical reference to Parry.

In growth-form *A. coccineus* is quite similar to *A. Newberryi,* and the pod is almost that of *A. funereus,* but the form and color of the flower and the exserted, symmetrical keel are unique and most remarkable in the *Argophylli.* The only New World species which it resembles at all in the corolla is the little known *A. orthanthus* Gray, a native of the uplands of central Mexico with bilocular legume, which also, curiously enough, combines the strict form of the petals with crimson (perhaps scarlet at first) coloring. From analogy with some *Scrophulariaceae,* etc., it might be supposed that the corolla of these species has evolved, or at least has come to survive, through fertilization by humming-birds, but there is no direct evidence that such is the case. The species cannot depend entirely on such visitors, since the anthers, as in all *Astragali* with which I am familiar, lie closely approximate to the stigma and ripen with it, thus ensuring self-fertilization. There can be no doubt that the brilliant color of the flower is attractive to birds. In Cushenbury Canyon on the Mohave Desert I have seen small passerine birds busily engaged in pecking at and devouring the petals of *A. coccineus,* much as the London sparrow delights in the unfolding buds of crocuses planted for ornament; and although the plants were abundant and in full anthesis it was impossible to find a perfect specimen for the press.

Astragalus coccineus is known to me only from California, but has been reported from southern Nevada by Tidestrom (1925, l. c.), and more precisely by Jepson from the Charleston Mts., where it may very well occur. The southernmost known stations are so close to the Mexican boundary that it seems impossible that it should not grow beyond it to the south.

16. ASTRAGALUS NEWBERRYI Gray

Cespitose and strictly acaulescent, the 1-several enlarged and heavy crowns seated immediately on the summit of a taproot, clothed below with a thatch of stiff, recurved, persistent petioles and peduncles; herbage densely canescent throughout with basifixed hairs, these commonly straight, appressed and silky in youth, becoming looser, more or less sinuous and cottony in age, the petioles commonly ascending-hirsute as well as striogse; stipules closely imbricated and concealed by the thatch, ovate to lance-ovate or acuminate, 5-9 (11) mm. long, pubescent without; leaves 2-13 (15) cm. long, the stout petioles (1) 2-5 (7) cm. long, persistent at least at base; leaflets (3) 5-13, obovate, broadly lanceolate or elliptic, rarely suborbicular, acute, rounded, truncate or even retuse at apex, thick in texture, equally pubescent on both faces; racemes subcapitately (3) 5-8-flowered, scarcely elongating and 0.5-1.5 (2) cm. long in fruit, on stout, at length reclinate peduncles nearly equalling or much shorter than the leaves; calyx (cylindric, 8-19 mm. long) loosely strigose-sericeous to villous-tomentose, the hairs either light or dark with either predominating, the subulate teeth one quarter to one half as long as the tube; corolla pink-purple, sometimes pale and the petals merely tipped with purple, variable in length (the banner 12-30 mm. long); pod obliquely ovoid to lance-ovoid, obtuse at base, obcompressed below and arched upward through half a circle or common-

ly less (scarcely at all in var. *Wardianus*) into a laterally compressed, deltoid to deltoid-acuminate beak, 1.3-2.5 cm. long, 8-11 mm. in greatest diameter, sulcate on either or both sutures, the valves leathery or woody, reticulate, densely villous and tomentose or simply villous with silky or cottony hairs 2-3 mm. long, the vesture commonly concealing the surface, but not the shape, of the valves; seeds black or brown, 2-3 mm. long.

In the inclusive sense, as treated here, *A. Newberryi* is composed of several races, of which only two of the more strongly marked and geographically restricted deserve recognition as varieties. The discriminating characters are summarized in the following key.

KEY TO THE VARIETIES OF A. NEWBERRYI

1. Pod thickly leathery or almost woody in texture, strongly arcuate-beaked, the vesture of the valves hirsute and tomentose with contorted hairs and concealing the surface of the valves (2).
   2. Flowers large, the banner 22-31 mm. long, the keel 17-25 mm. long; Arizona to Oregon, California, Utah and New Mexico ..... var. *typicus*
   2. Flowers smaller, the banner 14-18 mm. long, the keel 12-14 mm. long; northwestern Arizona ..... var. *Blyae*
1. Pod thinly leathery in texture, the beak short and straight or nearly so, the vesture of the valves silky-villous with almost straight hairs but not or scarcely tomentose, and not concealing the surface of the valves; central and western Utah ..... var. *Wardianus*

16a. var. typicus, nom. nov.

Astragalus Newberryi Gray var. *typicus* Barneby, nom. nov. *A. Newberryi* Gray, Proc. Amer. Acad. **12**:55. 1876. sensu restricto; Sheld., Minn. Bot. Stud. **1**:129. 1894; Jones, Proc. Calif. Acad. Sci. II, **5**:675. 1895; Cont. W. Bot. **10**: Pl. 6. 1902; Rev. Astrag. 217, Pl. 51. 1923; Coult. & Nels., Man. 387. 1909; Woot. & Standl., Cont. U. S. Nat. Herb. **19**:364. 1915; Tidestr., op. cit. **25**:329. 1925; Tidestr. & Kitt., Fl. Ariz. & N. Mex. 202. 1941; Clokey, Madroño **6**:241. 1942; Kearn. & Peeb., Fl. Pl. Ariz. 480. 1942; Abrams, Ill. Fl. Pac. St. **2**:575, fig. 2801. 1944. *Xylophacos Newberryi* (Gray) Rydb., Bull. Torr. Bot. Cl. **32**:662. 1906; op. cit. **52**:232. 1925; N. Amer. Fl. **24**:301. 1929.

A. eriocarpus Wats., Bot. King 71. 1871; Parry, Amer. Nat. **9**:142. 1875; Gray, Bot. Calif. **1**:151. 1876; non *A. eriocarpus* DC (1802). *A. Newberryi* Gray var. *eriocarpus* (Wats.) Jones, Proc. Calif. Acad. Sci. II, **5**:676. 1895. *Tragacantha Watsoniana* O. Kze., Rev. Gen. 942. 1891. *A. Watsonianus* (O. Kze.) Sheld., Minn. Bot. Stud. **1**:144. 1894; Tidestr., Cont. U. S. Nat. Herb. **25**:329. 1925; Peck. Man. Pl. Oreg. 444. 1941. *A. Newberryi* Gray var. *Watsonianus* (O. Kze.) Jones, Cont. W. Bot. **10**: 68, Pl. 6. 1902; Rev. Astrag. 216, Pl. 52. 1923. *A. suturalis* Sheld., Minn. Bot. Stud. **1**:23. 1894.

A. consectus Sheld., Minn. Bot. Stud. **1**:143. 1894, pro parte, quoad pl. Parryan. cit.

A. Newberryi Gray var. *castoreus* Jones, Proc. Calif. Acad. Sci. II, **5**:658. 1895; Cont. W. Bot. **10**: Pl. 6. 1902; Rev. Astrag. 217, Pl. 52. 1923; Jeps., Fl. Calif. **2**:361. 1936.

A. Purshii x *Watsonianus* Jones, Rev. Astrag. 216. 1923.

A. Chamaeleuce sensu Gray in Ives, Rep. Colo. R., Bot. 10. 1860, quoad pl. cit.; non *Phaca pygmaea* Nutt, basinym.

A. Purshii var. *tinctus* sensu Munz, Man. S. Calif. 266. 1935; Jaeger, Desert Wildflrs. 122. 1940; non Jones.

A. Purshii var. *longilobus* sensu Jaeger, op. cit., quoad fig. 258; non Jones.

A. funereus sensu Jaeger, op. cit., quoad fig. 243. *A Newberryi* Gray var. *funereus* sensu Clokey, Madroño **6**:214. 1942, quoad pl. cit.; non *A. funereus* Jones.

Calyx strigose-sericeous to somewhat hirsute or ascending-villous with either light or dark hairs, the tube 9.5-11 (13) mm., the teeth 2-5 (6) mm. long; corolla large, the banner 22-27 (30) mm., the wings 21-26 (28) mm., the keel 17-24 (25) mm. long; leaflets (3) 5-9 (13); pod stiffly leathery, 1.5-2.5 cm. long, strongly arcuate into a rigid, deltoid or deltoid-acuminate beak, the densely hirsute and tomentose vesture concealing the surface of the valves.

Type-locality.—On the frontiers of Utah and Arizona (i. e. northern Arizona); collected by J. S. Newberry on Lieut. Ives' Expedition, in April 1858.

Distribution.—Dry plains, sagebrush valleys and canyons of the pinyon-zone, from north-central New Mexico across northern Arizona to the eastern Mohave Desert in California, northward through Utah and Nevada to southern Idaho and interior Oregon; reported from Colorado and Wyoming.

Exsiccata (*selecta*).—ARIZONA. Northern Arizona, Newberry, 16 April 1858 (G, type, NY). *Coconino Co.:* Hermit Trail, Grand Canyon, Eastwood No. 5943 (CAS). *Mohave Co.:* Peach Springs, Jones in 1884 (G, NY, PO), Ripley & Barneby No. 3400. Black Rock Spring near Rioville, Nevada, Jones 5098f (PO). *Yavapai Co.:* S. of Ash Fork, Foster & Arnold No. 305 (G). CALIFORNIA. *Inyo Co.:* Panamint Mts., Coville & Funston No. 728 (M). Darwin, Jones in 1897 (PO). Waucopa Canyon, E. of Zurich, Ripley & Barneby No. 5880. *San Bernardino Co.:* Barnwell, Munz No. 13945 (PO). Keystone Spring, New York Mts., No. 13738 (PO). Bonanza King Mine, Providence Mts., Munz, Johnston & Harwood, No. 4231 (PO). IDAHO. *Twin Falls Co.:* S. of Rogerson, Ripley & Barneby No. 6468 (Poc). NEVADA. *Clark Co.:* Kyle Canyon, Charleston Mts., Clokey No. 7168, 7169 (NY), Ripley & Barneby No. 3411. Deadman Canyon, Sheep Mts., No. 2904. *Elko Co.:* W. of Wendover, Jones No. 25423 (PO). Elko, Holmgren No. 1027 (NY), Ripley & Barneby No. 5560 (CAS). E. of Carlin, No. 4586 (CAS). *Esmeralda Co.:* Palmetto Range, Purpus No. 5868 (PO). *Lander Co.:* Battle Mt., Ripley & Barneby No. 5594. *Lincoln Co.:* Highland Range, No. 3485a. *Mineral Co.:* E. of Basalt, No. 3723. *Nye Co.:* E. of Manhattan, Train No. 2721 (NY). Currant Creek, Bentley No. 5 (NY). *Pershing Co.:* Coyote Mts., Watson No. 273 (G, type of *A. eriocarpus*, NY). West Humboldt Mts., E. of Woolsey, Ripley & Barneby No. 5647. *White Pine Co.:* Aurum, Jones in 1891 (NY, PO). NEW MEXICO. *McKinley Co.:* W. of Gallup, McKelvey No. 4594 (G). *San Juan Co.:* Aztec, Baker No. 420 (G, NY, PO). *Santa Fe Co.:* N. of Cerrillos, Ripley & Barneby No. 7539. *Taos Co.:* N. of Rinconada, No. 7555. OREGON. *Deschutes Co.:* Millican, Peck No. 13392a (CAS). *Harney Co.:* Narrows, No. 25012 (CAS). UTAH. *Beaver Co.:* Milford, Jones in 1880 (PO). *Garfield Co.:* Red Canyon near Bryce, Eastwood & Howell No. 788 (CAS, in part). *Iron Co.:* Cedar City, Jones No. 5197 (PO). Iron Mt., Ripley & Barneby No. 4376. *Kane Co.:* Kanab, Eastwood & Howell No. 9307 (CAS). *Sevier Co.:* Joseph City, Jones No. 6227 (PO). *Tocele Co.:* Detroit, Jones in 1891 (PO). Mt. Ibapah, in 1891 (PO). *Washington Co.:* Beaver Dam Mts., Parry No. 44 (G). W. of St. George, Jones No. 5006 (PO, type of *A. Newberryi* var. *castoreus*, NY).

The first and typical collection of *A. Newberryi*, the most condensed, vernal form of the species from a very dry habitat, is in flower only. Gray, who prepared the account of the botany of the Ives Expedition, took these fragments to be conspecific with *Phaca pygmaea* Nutt. and, noticing that the

combination *A. pygmaeus* was preoccupied, proposed the substitute *A. Chamaeleuce* Gray. The latter is based wholly on *P. pygmaea,* and is the proper name for that species. More than a decade later Gray received from Lester Ward a fruiting specimen from the mountains of Utah (E. of Glenwood, Sevier Co.), and this enabled him to correct the original misidentification of Newberry's plant, which he thereupon named in honor of its discoverer. Unfortunately the Ward specimen, from which the pod of *A. Newberryi* came to be described, is not *A. Newberryi* var. *typicus* as accepted here, but belongs to the relatively rare race with thinner and more thinly hirsute legume described as var. *Wardianus* below, and thus *A. Newberryi* in Gray's sense was a mixture. In fact Gray never understood the species, for he referred to it (in herb.) only one other collection (Palmer's *A. eurekensis* from Paragonah, Utah, similar to Ward's plant in the pod's relatively thin vesture), and when he did obtain true *Newberryi* from Parry[9]), he failed to recognize it. In spite of this confusion, there seems be no difficulty in extracting from the type-description the flowering element of the mixture, and limiting the name to the plant represented by Newberry's specimens.

In contrast to the tiny flowering plants obtained by Newberry, the like of which are not uncommon in early spring on the calcareous plateaux of northern Arizona, the type of *A. eriocarpus* Wats. represents the robust extreme of the species and is in advanced fruit. No one, faced with these two specimens alone, from opposite ends of the species-range, would hesitate in accepting them as at least varietally distinct. But throughout central Nevada, where *A. Newberryi* is commonest, occur innumerable intermediates, in which all the characters by which they have been separated intergrade independently. Thus there are forms with long calyx-teeth and few obtuse leaflets; with short calyx-teeth and more numerous leaflets either obtuse or acute; while large flowers and small are interchangeable with either combination. Often two forms will grow together or in close proximity, the more robust, with deeply cleft and often dark hairy calyx favoring rich soil in the shelter of sagebrush, and on an exposed ridge nearby the dwarf form, with canescent, short-toothed calyx, and commonly fewer or narrower leaflets. The more luxuriant form has also been confounded with *A. funereus,* both by Jones himself (as to his Californian gatherings referred there in Rev. Astrag.) and more lately by Clokey. This differs, however, in being caulescent, with deciduous petioles, and lacking the thick root-crown so characteristic of *A. Newberryi.* Moreover the pubescence of the herbage is looser and more tangled, but in *A. Newberryi* itself

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9 This specimen, Parry No. 44 (G), has had a remarkably unsettled history. First identified (almost correctly, as it turns out) by Parry as *E. eriocarpus* Wats. (cf. Amer. Nat., l. c., where the locality, not given on the label, is described as "quite frequent along the edge of dry ravines in the Beaver Dam Mts."), it was expressly referred to *A. Purshii* by Gray, Bot. Calif. **1**:151. Jones seems to have accepted this, though the type of his *A. Newberryi* var. *castoreus* must have come from almost the same spot ("18 miles") west of St. George, Utah, and is precisely similar. Subsequently Sheldon cited it as part of his mixed proposition *A. consectus;* and the *Xylophacos consectus* of Rydberg, Fl. Rocky Mts. 505. 1917, is based on it. And finally it came to rest as an important element of Rydberg's *Xylophacos medius.*

this character is variable, for although the vesture is in youth appressed and silky, later in the year, as the pod matures and the plant-tissues begin to dry out, the hairs commonly become more spreading, hirsute rather than strigose, and less shining in quality. The var. *typicus* as here defined is best represented by the form known as var. *castoreus* Jones, which is about intermediate in every respect between the two extremes, and is the common, normally developed plant throughout the range of the species.

16b. var. **Blyae** (Rose), comb. nov.

Astragalus Newberryi Gray var. *Blyae* (Rose) Barneby, comb. nov. *Xylophacos Blyae* Rose ex *Rydb.*, N. Amer. Fl. **24**:303. 1929. *A. Blyae* (Rose) Tidestr., Proc. Biol. Soc. Wash. **50**:20. 1937; Tidestr. & Kitt., Fl. Ariz. & N. Mex. 203. 1941; Kearn. & Peeb., Fl. Pl. Ariz. 480. 1942.

A. funereus sensu Abrams, Ill. Fl. Pac. St. **2**:577. 1944, pro parte; non Jones.

Calyx villous-hirsute with dark, rarely with light, hairs, the tube 5-7 (8) mm., the teeth 2-3 mm. long; corolla purple, the banner 14-18 (22) mm., the wings 13-16 (21) mm., the keel 12-14 (19) mm. long; leaflets 9-13 (15); pod stiffly leathery or almost woody, 1.3-2.3 cm. long, arcuate throughout, or straightish below and with a strongly incurved beak, the densely hirsute and tomentose vesture concealing the surface of the valves.

Type-locality.—One and one half miles northwest of Kingman, Arizona; collected by Mrs. Charles Bly in 1925 (fr.) and 1927 (fl.).

Distribution.—Dry rocky hills and canyons, at the upper edge of the Lower Sonoran zone, alt. 3500-4400 ft., known only from Mohave County, Arizona.

Exsiccata.—ARIZONA. *Mohave Co.:* Kingman, Mrs. Bly in 1928 (G, P). 2 miles E. of Kingman, Ripley & Barneby No. 3389. Hackberry, Jones in 1903 (PO), Kearney & Peebles No. 11299 (CAS). Black Ute Mts., No. 13123 (CAS, G). Chloride, Jones, 14 April 1903 (PO), Ripley & Barneby No. 3378 (CAS).

The var. *Blyae* differs from var. *typicus* solely in the smaller calyx and corolla, in every other way closely resembling the state of the latter which has been known as var. *castoreus* Jones. Occurring as it does at the edge of the Lower Sonoran, where it is sometimes associated with *Larrea*, it matures very early, and most of the collections available are in advanced fruit. At this stage the pubescence of the herbage becomes hirsute and ascending or spreading (as it does in much of var. *typicus* at the equivalent season), but it seems to be more closely appressed and sericeous in the young plant (cf. Mrs. Bly in 1928), and the orientation of the hairs is thus an unreliable supporting character. Though usually dark, the hairs of the calyx may be all light (Chloride, Jones, 14 April 1903), and the dimensions of the calyx and corolla are variable, at the largest extreme closely approaching var. *typicus*. A specimen collected at Chloride by Jones on 15 April, 1903, is a case in point, where the banner reaches 22 mm., and the calyx-tube and teeth together 11-12 mm. in length. Conceivably, however, as suggested by Dr. Kearney's manuscript annotation of the sheet (PO), this individual is a hybrid between var. *Blyae* and

the giant form of *A. tephrodes* var. *brachylobus* (*A. chloridae*) which grows nearby; were it not for the locality it would probably be referred to var. *typicus*. The reduction by Abrams of *A. Blyae* to the distinct Death Valley endemic *A. funereus* is quite unwarranted.

16c. var. **Wardianus**, var. nov.

A. Newberryi sensu Gray, Proc. Amer. Acad. **12**:55. 1876, pro parte, quoad fruct.; Jones, Rev. Astrag. Pl. 51, fig. b. (sect. transvers. legum.). 1923.

A var. *typico*, cui caeterius praesimilis, leguminis magis inflati vix vel brevissime arcuato-rostrati valvulis chartaceis, nec coriaceo-lignescentibus, pube e pilis subrectis patulis tenuiter hirsuto-villosis, nec densissime tomentosis, aberrans.

Similar in every way to var. *typicus*, but the pod more inflated, thinner in texture and scarcely more than chartaceous or thin-leathery, not rigid, the vesture of the valves silky-hirsute with nearly straight hairs, not or scarcely tomentose, and not concealing the surface of the valves.

Type.—Canyon east of Glenwood, Sevier County, Utah, L. F. Ward No. 223 in 1875 (Gray Herbarium, mounted on the same sheet as the type of *A. Newberryi* var. *typicus*).

Distribution.—Open sandy slopes of the pinyon-zone, 6-7000 ft. altitude, in the mountains of central and western Utah.

Exsiccata.—UTAH. *Piute Co.:* Marysvale, Jones, June 1, 1894 (PO), No. 53381 (PO), in 1899 (PO). *Sevier Co.:* East of Glenwood, Ward No. 223 (G, type, PO, fragment). 10 miles E. of Salina, Ripley & Barneby No. 4758. *Tooele Co.:* Willow Spring Pass near Ibapah, Jones in 1891 (PO).

As implied above, in the discussion of var. *typicus*, the variety *Wardianus* is based on the collection from which Gray originally described the fruit of *A. Newberryi*. The plant which I have taken as the type is mounted on the same sheet with the diminutive flowering specimen obtained by Newberry in Arizona (type of var. *typicus*) and, although lacking an authentic label, is no doubt that referred to by Gray as having been collected by Ward near Glenwood on the Powell Expedition. The legume is of a much more papery texture than that of *A. Newberryi* proper, and in its thin vesture, through which the surface of the valves is fully visible, it resembles that of the allied *A. eurekensis* Jones. Misled by this similarity, Gray himself referred to *A. Newberryi* (in herb.) the only material of *A. eurekensis* which reached him (Palmer in 1877, from Paragonah), a specimen of which is also mounted on the type-sheet. From the latter species, with which it is sometimes associated in nature, var. *Wardianus* is at once distinguished by the spreading hairs on the petioles and peduncles, the silvery and not leaden hue of the foliage, and the much less rigid, inconspicuously beaked legume. Though probably but a minor form of the species, its facies in fruit is so different from that prevailing elsewhere in the extensive range of var. *typicus*, that it seems worth recording by a formal diagnosis; but further observation of its occurrence in the field is needed to establish its true value.

17. ASTRAGALUS EUREKENSIS Jones

Astragalus eurekensis Jones, Cont. W. Bot. **8**:12. 1898; Rev. Astrag. 217, Pl. 52. 1923; Tidestr., Cont. U. S. Nat. Herb. **25**:328. 1925. *Xylophacos eurekensis* (Jones) Rydb., Fl. Rocky Mts. 504, 1063. 1917; Bull. Torr. Bot. Cl. **52**:234. 1925; N. Amer. Fl. **24**:301. 1929.

A. Newberryi x *eurekensis* Jones, Rev. Astrag. 217. 1923. *Xylophacos medius* Rydb., Bull. Torr. Bot. Cl. **52**:232. 1925; N. Amer. Fl. **24**:301. 1939.

A. glareosus sensu Jones, Zoë **3**:291. 1893; non Dougl.

A. eriocarpus sensu Jones, op. cit. 293; non Wats.

Strictly acaulescent, the leaves and peduncles tufted on the short divisions of the stout root or closely cespitose and enlarged caudex branches; herbage strigose-sericeous with fine, closely appressed, straight, basifixed hairs, the whole vesture of a dull or leaden hue; stipules closely imbricated, broadly lanceolate, scarious, pubescent mostly with dark hairs, or at length glabrate; leaves erect and spreading, (2) 4-15 cm. long, the petioles somewhat shorter than the rachis, persistent (like the peduncles) at base and forming a thatch on the root-crown; leaflets (3) 5-11 (17), oblong-obovate to rhombic-lanceolate or -oblanceolate, acute or acutish, 5-25 mm. long, sericeous on both faces; peduncles (1) 2.5-7 (14) cm. long, somewhat surpassed by the leaves, arcuate-reclinate in fruit; racemes very shortly (1) 4-7-flowered, less than 1 cm. long in fruit; calyx strigose, partly with dark hairs, the cylindric tube (7) 9-11 mm., the subulate acute teeth 2.5-4 mm. long; corolla ochroleucous, more or less veined or suffused with lurid purple, the keel-tip dark, or rarely purple throughout; banner 23-26 mm., the wings 20-24 mm., the keel 18-22 mm. long; pod obliquely lance-ovoid, obcompressed toward the obtuse or slightly emarginate base, arcuate and acuminate upward into the laterally compressed, proriform beak, 1.5-3 (4) cm. long, about 9 mm. in greatest diameter, slightly sulcate at the very base, the sutures otherwise prominent and subcarinate, the valves firmly leathery or almost woody, brown and strongly rugose-reticulate, villous-hirsute but not at all tomentose, the hairs about 2.5 mm. long, shining, commonly becoming tawny in age, not concealing the surface of the valves; mature seeds not seen.

Type-locality.—Eureka, Utah; collected by M. E. Jones in 1891.

Distribution.—Clay benches and hillsides, on limestone or sandstone, often in shade of juniper or pinyon, common about Utah Lake and southward along the ranges enclosing the Sevier River to southern Utah.

Exsiccata.—UTAH. *Beaver Co.:* Milford, Jones No.1743a (G). *Garfield Co.:* Dog Valley, Jones No. 1690 (NY, PO). *Iron Co.:* Paragonah, Palmer in 1877 (G). *Juab Co.:* Eureka, Jones in 1891 (PO, type of *A. eurekensis*, G). Homansville, Jones in 1891 (PO, cotype, G). Silver City, Jones in 1890 (PO). Nephi, Jones in 1910 (PO). *Sanpete Co.:* Ephraim, Tidestrom No. 2083 (NY). *Sevier Co.:* Richfield, Jones in 1899 (PO). Salina Canyon, No. 5116b (PO). Pavant Range, Ripley & Barneby No. 4776 (CAS). *Tooele Co.:* Johnson's Pass, Jones in 1900 (PO). Desert Mt., E. of Detroit, Jones in 1901 (PO). Lake Point, Jones No. 1743 (PO, type of *A. Newberryi* x *eurekensis*, NY, type of *X. medius*), No. 1743b (G). *Utah Co.:* Cedar Fort, Jones in 1896 (G). Mercur, in 1896 (PO). West side of Utah Lake, Decker No. 26-14 (NY).

With one exception discussed below, the material of *A. eurekensis* is pretty uniform, although varying a little, as would be expected among the *Argophylli*, in stature, in the number of leaflets to the leaf, and in the density of the pod's vesture. As a rule the corolla is ochroleucous, but veined with lurid purple, and the extremities of the petals are often suffused with similar leaden color. The unusual plant with bright purple flower from Lake Point, which Jones first identified with *A. eriocarpus* Wats. and later considered to be a hybrid between *A. Newberryi* and *A. eurekensis*, eventually formed the typical element of *Xylophacos medius* Rydb. Rydberg claimed that this species differed from *A. eurekensis* in its "more brightly colored corolla, and less numerous, larger and comparatively broader leaflets"; and subsequently, in the North American Flora offered a further character in the more densely woolly pod. In addition to the type, he cited two other collections, Parry No. 44 from southern Utah and Jones No. 1743 from Garfield County, both at the extreme southern limit of the range of *A. eurekensis*. The first of these is in flower, and the corolla is purple, but the plant belongs unquestionably to *A. Newberryi* var. *typicus;* the second is nothing but *eurekensis*, and it is worth noting that the sheet of this collection in the Gray Herbarium bears the annotation in Jones' hand: "flowers yellowish white, purple-tipped," i. e. the characteristic coloring for the species. Furthermore a specimen referred by Rydberg to *A. eurekensis*, Tidestrom No. 2083, often has only five leaflets (a character supposedly of *X. medius*) though the pod of *eurekensis*, and the reverse combination is found in numerous collections. In fact *X. medius* rests solely on its type, and this differs from *A. eurekensis* only in the purple corolla. It is conceivable, as Jones thought, that it did arise through hybridization with *A. Newberryi*. The latter is not yet known to occur as far north in Utah as the Great Salt Lake, but it could do so, and *A. eurekensis* is common in the region. Since it appears to have inherited nothing from one of its supposed parents except the color of the petals, it quite as likely represents no more than a minor, local variation such as is known to occur in other species of the group, e. g. *A. Chamaeleuce*, and its recognition, even as a variety, seems undesirable at present.

Astragalus eurekensis is intimately allied to *A. Newberryi*, with which it is associated through the southern half of its range, and the two species vary within much the same limits and in parallel ways. Although so much alike in form, there is seldom, if ever, difficulty in separating them. In *A. eurekensis* the pubescence of the whole plant is sparser, and strictly appressed even on the petioles and peduncles; while the herbage (at least when dried) assumes a leaden or dull greenish hue quite unlike the dense white or silvery vesture of *A. Newberryi*. And the lance-acuminate pod, relatively thinly hirsute with shining hairs which commonly become tawny or dark in age, is characteristic and distinctive. Early confusion of the species with others was frequent. In 1893 Jones gave the first good account of it, under the name of *A. glareosus*, and on realizing the error he based his proposed *A. eurekensis* on that description, without citing any specimens. In Jones' herbarium there are two gatherings, both made on 16 May 1891, marked "Type" in his hand, that from Eureka

(with flower and forming pod) and that from Homansville (in fruit). Rydberg chose the former alone as typical, but they are perhaps better regarded as cotypes.

18. ASTRAGALUS MARIANUS (Rydb.) Barneby

Astragalus marianus (Rydb). Barneby, Proc. Calif. Acad. Sci. IV, **25**:150. 1944. *Xylophacos marianus* Rydb., Bull. Torr. Bot. Cl. **52**:233. 1925; N. Amer. Fl. **24**:301. 1929.

A. Purshii x *Newberryi* Jones, Rev. Astrag. 216. 1923.

Subacaulescent or with evident, prostrate stems 1-3 cm. long, rising from the slender divisions of a branched caudex or, in young plants, from the crown of a pluricipital taproot; herbage densely strigose-sericeous throughout with short, straight, appressed or strictly ascending, basifixed hairs, rarely more thinly so and greenish; stipules loosely imbricated to shortly discrete, ovate-acuminate to deltoid, 3-7 mm. long, mostly as broad as the stem, membranous, appressed-hirsute, becoming castaneous and glabrate; leaves arcuate-spreading, (1.5) 3-8 cm. long, the slender, usually altogether deciduous petioles (1) 2-3 cm. long; leaflets (9) 11-17, obovate to broadly oblanceolate, obtuse-truncate to shortly acute or mucronate, 3-9 (11) mm. long, equally pubescent on both faces; peduncles stout, shorter than or rarely equalling the leaves, 1-5 cm. long, at length arcuate-reclinate; racemes subcapitately 3-8-flowered, 1-1.5 cm. long in fruit; calyx strigose-hirsute, nearly always with some dark hairs, the cylindric tube 8-11 mm., the subulate, nigrescent teeth 2-3.5 mm. long; corolla pale, the petals, especially the wings and keel, purple-tipped, their claws whitish, the banner 20-24 mm., the wings 19-21 mm., the keel 16-20 mm. long; pod obliquely ovoid, obcompressed below and arcuate through 90° or less into a deltoid or deltoid-acuminate, laterally compressed beak, 1.2-2.2 cm. long, slightly sulcate ventrally but not or scarcely so dorsally, the stiffly leathery valves reticulate and densely shaggy-tomentose with spreading, sinuous hairs about 2 mm. long, the vesture usually concealing the surface of the valves, rarely thinner; seeds black, minutely pitted, 3 mm. long.

Type-locality.—Marysvale, Utah; collected by M. E. Jones in 1894.

Distribution.—Dry gravelly hillsides and benches among juniper and pinyon, or in open pinewoods, along the Sevier River in southwestern Utah and in adjacent Nevada.

Exsiccata.—NEVADA. *Lincoln Co.:* Muddy River Valley near Caliente, Ripley & Barneby No. 6325 (CAS). Highland Range, No. 6408. Silver Canyon, Mt. Irish, Jaeger in 1938 (PO). Comet Peak near Pioche, Jones in 1912 (PO). 20 miles N. of Pioche, Ripley & Barneby No. 6335. Geyser Ranch, No. 6325 (CAS). *White Pine Co.:* Spring Creek, Jones in 1891 (PO). Snake Creek, Snake Range, Ripley & Barneby No. 4036 (CAS). UTAH. *Iron Co.:* Cedar City, Jones No. 5198 (PO), 5200 (NY). Iron Mt., Ripley & Barneby No. 4375. 15 miles S. of Cedar City, Barkley & Reed No. 4078 (PO). *Piute Co.:* Marysvale, Jones No. 5355 (NY). Gold Mt., Jones in 1898 (PO). *Sevier Co.:* Fish Lake Canyon, Garrett No. 2513 (NY).

Astragalus marianus is apparently the plant described by Jones from the Sevier Valley as a hybrid between *A. Purshii* and *A. Newberryi*. Although it occurs in immediate association with the latter, it seems to be nowhere present

in the common range of both supposed parents, and its hybrid origin is most unlikely. Rydberg, describing it as a species, placed it in his series *Eriocarpi*, on account of the sericeous vesture of the herbage combined with a shaggy-tomentose pod, but it differs from other members of the group in having a developed caudex with (in mature specimens) slender branches, not densely invested with a thatch of marcescent petioles. It thus resembles, and is at times difficult to separate from, *A. argophyllus* var. *pephragmenoides*. The corolla, however, is nearly always longer, the almost silver-plated pubescence of the leaves is composed of straighter, more closely appressed hairs, and the pod lacks the prominent, thick ventral suture apparent in *A. argophyllus*. Atypical forms of var. *pephragmenoides* with rather densely pubescent legume are, nevertheless, so similar to forms of *A. marianus* with relatively sparsely shaggy legume, that an almost complete series exists between the truly strigose condition found in *A. argophyllus* var. *typicus*, through the intermediate var. *pephragmenoides*, to the densely woolly one of *A. marianus*. Since the latter occupies a gap between the isolated southern station of var. *pephragmenoides* on the Kaibab Plateau and its reappearance on the Wasatch, it may represent the *argophyllus* complex in its somewhat restricted area.

The type-collection of *X. marianus* is apparently represented only in the New York Botanical Garden. The specimen at Pomona collected by Jones at Marysvale on the same date, 1 June 1894, and another obtained the previous day, belong to *A. Newberryi* var. *Wardianus*. The Fremont gathering from Utah Lake (NY) referred to *X. marianus* by Rydberg (1925, l. c.) is in flower only, but seems to be typical *A. argophyllus;* while I myself have determined some other listed material as var. *pephragmenoides*.

A peculiar plant from central Utah (Indianola, Tidestrom No. 2249, G), distributed as *A. Purshii* but seemingly closer to *A. marianus* (to which it would run in my key to the species) should be noticed here. Resembling *A. marianus* in the quality of the pubescence, it differs in the remote leaflets, much smaller flower (calyx-tube 5 mm., teeth 1.5-2 mm. long; banner 16 mm., wings 13 mm., keel 11 mm. long), and small, shaggy-villous pod about 1 cm. long. It is perhaps an undescribed variety of *A. marianus*, but the material is insufficient for diagnosis.

19. ASTRAGALUS FUNEREUS Jones

Astragalus funereus Jones, Cont. W. Bot. **12**:11. 1908; Rev. Astrag. 219, Pl. 53, exclus. fig. b, bb. 1923; Munz, Man. S. Calif. 266. 1935; Jaeger, Desert Wildflrs. 115, pro parte, exclus. fig. 243. 1940; Abrams, Ill. Fl. Pac. St. **2**:577, fig. 2804. 1944, exclus. syn. et loc. ariz. *Xylophacos funereus* (Jones) Rydb., Bull. Torr. Bot. Cl. **52**:367. 1925; N. Amer. Fl. **24**:303. 1929. *Astragalus Purshii* Dougl. var. *funereus* (Jones) Jeps., Fl. Calif. **2**:360. 1936. *A. Newberryi* Gray var. *funereus* (Jones) Clokey, Madroño **6**:214. 1942, quoad nom., exclus. pl. cit.

A. Purshii Dougl. var. *tinctus* sensu Tidestr., Cont. U. S. Nat. Herb. **25**:329. 1925, pro parte, e syn.; non Jones.

Caulescent, the several white-tomentose stems 3-6 cm. long, prostrate, radiating from the summit of a thick taproot, forming loosely matted plants;

herbage densely white-pubescent with curly, tangled and more or less spreading hairs, cottony-tomentose and villous but scarcely or not at all silky; stipules broadly deltoid, 4-8 mm. long, at least the upper discrete; leaves 2-5 cm. long, the feebly persistent or wholly deciduous petioles 1-2 cm. long; leaflets (7) 11-15, subcontiguous, broadly ovate with cuneate base, oblong or elliptic, obtuse or barely acute, 4-11 mm. long, thick and equally pubescent on both faces; racemes 3-8-flowered, 1-2.5 cm. long in fruit; calyx shortly but densely villous, usually with many dark hairs, the cylindric tube 8-9 mm., the teeth 2.5-4 long; corolla purple, the petals subequal or the wings slightly shorter than the keel and banner, the latter 21-26 mm., the wings 21-24 mm., the keel 21.5-26 mm. long; pod obliquely oblong- or ovoid-acuminate, 2.5-4 cm. long, 1-1.5 cm. in greatest diameter, obtuse and obcompressed at base, gently arcuate upward into the compressed, narrowly deltoid beak, the valves leathery but scarcely rigid, densely villous-tomentose with spreading and tangled, shining hairs 1.5-2 mm. long; seeds brown, about 3 mm. long.

Type-locality.—Rhyolite, Nevada, in clay soil mixed with gravel on high ridges where the soil was very poor, altitude 4300 feet[10]; collected by M. E. Jones in April 1907.

Distribution.—Clay ridges and canyon walls in the mountains along the eastern border of the Death Valley sink in southern California and adjacent Nevada.

Exsiccata.—CALIFORNIA. *Inyo Co.:* Open wall of narrow canyon. Leadfield, Grapevine Mts., Munz No. 16436 (PO). Leadfield, J. T. Howell No. 7767 (CAS). NEVADA. *Nye Co.:* Rhyolite, Jones in 1907 (PO, type, G, NY).

Astragalus funereus is one of the remarkable narrow endemics of the Death Valley region. It has, however, been little appreciated, having been subordinated as a variety either to *A. Purshii* or *A. Newberryi*, and confused with the latter by Jones himself. The so-called *A. funereus* from Darwin, California, cited by Jones in the Revision of Astragalus, as well as the robust plants from the Charleston Mts. referred here by Clokey (l. c.), are nothing more than forms of *A. Newberryi* with dark-hairy calyx and large flowers, inseparable from the state of that species which has been known as var. *Watsonianus* (O. Kze.) Jones (cf. discussion of *A. Newberryi*). Among the very numerous collections of *A. Newberryi* examined, all have in common the strictly acaulescent habit, the thick crown of the root invested (except in seedling plants) with a thatch of persistent petioles and closely imbricated stipules. This growth-form is absolutely characteristic of *A. Newberryi*, and quite at variance with the caulescent, loosely tufted habit of *A. funereus*, with its well-developed in-

10 The type-locality as recorded by Jones is probably misleading. The altitude of Rhyolite is approximately 3400 feet, and if the plants were really collected, as seems very likely, on "high ridges . . . at 4300 feet," they must have come from a mountain range at some distance from the town. In 1907 Jones is known to have penetrated Death Valley where, in the Funeral Mts. (a southern extension of the Grapevines), he collected among other things the endemic *Salvia funerea* Jones. It is to be suspected that the *Astragalus* was actually found in the Grapevine Mts. to the west of Rhyolite, probably within the present confines of the Death Valley Monument, conceivably in California.

ternodes, discrete stipules and almost or entirely deciduous petioles. The quality of the pubescence, less fine and tangled than in the *A. Purshii* alliance, but much more so than in *A. Newberryi*, is another distinguishing character; while the curiously exserted keel, which either equals or slightly surpasses the wings, is distinctive and, except for the very different *A. coccineus*, unique among the *Argophylli*.

The reduction by Abrams of *A. Blyae*, a small-flowered variety of *A. Newberryi*, whence the apparent extension of the range of *A. funereus* to include Arizona, is unfortunate. The only feature in common between the two is the dark-hairy calyx, scarcely a reliable character.

20. ASTRAGALUS UTAHENSIS (Torr.) T. & G.

Astragalus utahensis (Torr.) T. & G., Pac. RR. Rep. **2**:120. 1855; Gray, Proc. Amer. Acad. **6**:213. 1864; Bot. Calif. **1**:151. 1880, pro max. parte; Wats., Bot. King 72, 440. 1871, pro max. parte; Jones, Zoë **3**:292. 1893; Rev. Astrag. 220, pro max. parte, Pl. 53, 54. 1923; Sheld., Minn. Bot. Stud. **1**:154. 1894; Coult. & Nels., Man. 287. 1909, pro parte; Tidestr., Cont. U. S. Nat. Herb. **25**:329. 1925; Abrams, Ill. Fl. Pac. St. **2**:577, pro parte, exclus. syn., fig. 2805. 1944. *Phaca mollissima* Nutt. var. *utahensis* Torr. ap Stansb., Explor. Gt. Salt Lake 385, Tab. 2, exclus. fig. 4. 1853. *Tragacantha utahensis* (Torr.) O. Kze., Rev. Gen. 949. 1891. *Xylophacos utahensis* (Torr.) Rydb., Bull. Torr. Bot. Cl. **40**:49. 1913; op. cit. **52**:367, 1925, exclus. num. cit. plur.; Fl. Rocky Mts. 506. 1917, exclus. syn.; N. Amer. Fl. **24**:304. 1929.

A. utahensis fma. *umbellulata* Gand., Bull. Soc. Bot. Fr. **48**:xvi. 1902.

Caulescent from a stout vertical taproot, forming broad matted plants 4-5 dm. broad, or sometimes depauperate, densely cespitose and subacaulescent; stems prostrate, evident even though very short, up to 1.5 (2) dm. long, white tomentose; herbage densely pannose-tomentose with matted cottony hairs, not at all sericeous; stipules lanceolate- or ovate-acuminate, (3) 5-10 mm. long, commonly drawn out into threadlike tips, membranous, at first more or less concealed by tomentum but at length glabrescent above; leaves (2) 5-12 cm. long, the feebly persistent or wholly deciduous petioles (1) 2-4.5 cm. long; leaflets (7) 17-19, broadly obovate to suborbicular, obtuse, (3) 5-15 mm. long, appearing thick from the matted white vesture on both faces, rarely thinner and greenish; racemes 3-8-flowered, (0.5) 1-2 cm. long, on stout at length reclinate peduncles (1) 3-10 (15) cm. long; calyx membranous, purple-tinged, somewhat turgid, loosely arachnoid-villous, the tube 8-11 mm., the often nigrescent teeth (2) 2.5-4 mm. long; corolla brilliant pink-purple, the ample oblanceolate-obovate banner 21-29 mm., the wings 19-27 mm., the keel (16) 18-22 mm. long, the lunate blades of the latter gently incurved through 100° to the obtuse apex; pod (excluding the vesture) lance-acuminate, cuneate or rounded at base, nearly straight to gently arcuate throughout but not with a conspicuous, incurved beak, dorsiventrally compressed except at apex, 2-3.5 cm. long, 5-7.5 mm. in greatest diameter, commonly sulcate ventrally but little or not at all so dorsally, the valves thinly coriaceous or subchartaceous, 0.2-0.3 mm. thick when dry, transversely reticulate but not rugose, so densely shaggy-villous with shining, silky, cream-colored or pale yellow spreading hairs 4-7

mm. long as to conceal entirely the shape and surface of the pod, which thus appears ovoid in outline; seeds numerous, castaneous, 2 mm. long.

Type-locality.—Shores and islands of the Salt Lake, Utah; collected by Capt. Howard Stansbury in 1850.

Distribution.—Stony hillsides and open banks, in light, often calcareous soils, alt. 4250-8000 ft., from southern Idaho and southwestern Wyoming throughout the Salt Lake and Sevier basins and the western edge of the Navajo Basin in Utah to east-central Nevada.

Exsiccata (*selecta*).—IDAHO. *Bannock Co.:* Mink Creek, Davis No. 46-32 (Poc). *Bear Lake Co.:* Montpelier, Macbride No. 22 (G). NEVADA. *Eureka Co.:* W. of Eureka, Ripley & Barneby No. 6231 (CAS). *Lincoln Co.:* Geyser Ranch, No. 4417 (CAS). *Nye Co.:* Currant Creek, Eastwood & Howell No. 9403 (CAS, G). *White Pine Co.:* Aurum, Jones in 1893 (PO). Lehman Cave, Maguire & Becraft No. 2667 (PO). UTAH: *Co. unknown:* Island in Great Salt Lake, Fremont, 2nd Expedition, in 1843 (G). Wasatch Mts., Watson No. 275, in part (G, NY). *Boxelder Co.:* Collinston, C. P. Smith No. 2351 (NY). *Cache Co.:* Logan, B. & R. Maguire No. 3525 (G). *Carbon Co.:* Castlegate, Jones No. 5486c (PO). *Duchesne Co.:* 10 miles S. of Theodore, No. 5639h (PO). *Piute Co.:* Marysvale, No. 5324 (NY, PO). *Salt Lake Co.:* Salt Lake City, Rydberg No. 6053 (NY). Big Cottonwood Canyon, Ripley & Barneby No. 4625 (CAS). *Sanpete Co.:* Ephraim, Tidestrom No. 2108 (G, NY). *Sevier Co.:* E. of Salina, Ripley & Barneby No. 4757. *Summit Co.:* Bear River Valley, Goodman No. 1832 (G, NY). *Tooele Co.:* West shore of Great Salt Lake, Stansbury, 24 June 185011 (NY, type of *Phaca mollissima* var. *utahensis*). *Wasatch Co.:* Hot Springs near Midway, Eastwood & Howell No. 497 (CAS). *Wayne Co.:* Loa Pass, Jones No. 5639h (PO). WYOMING. *Uinta Co.:* Evanston, A. Nelson No. 4514 (G, NY, P., type-collection of *A. utahensis* fma. *umbellulata*).

Astragalus utahensis was first encountered by Fremont in September, 1843, on one of the islands in Great Salt Lake, but it remained undescribed until Stansbury brought back from the same region more ample material. Stansbury himself (Rep. Gt. Salt Lake, p. 102) reports the discovery, on October 23, 1849, of the dried pods "covered with a substance resembling cotton . . . with the appearance of oval white balls," but the fine flowering plants collected in the following spring formed the basis of Torrey's description and figure. The species is abundant throughout the Salt Lake Basin, extending thence, but less commonly, over the Wasatch into southwestern Wyoming and the edge of the Navajo Basin, to extreme southern Idaho, south along the Sevier, and across into eastern Nevada. In most modern floras, as well as in the monographs of Jones and Rydberg, a much wider distribution is indicated, the species being said to range as far north as Montana, west to Harney County, Oregon and northern California (Abrams), and east to Colorado (Coulter & Nelson), but no material substantiating these records has been seen. It is apparent that two separate races, superficially resembling *A. utahensis* in their rounded leaflets and densely pannose herbage but differing in that the legume is strongly arcuate-beaked and much more shortly and stiffly villous-hirsute (having, in fact, the pod of *A. Purshii*), have been masquerading under the name *A.*

11 On this day, according to his report, Stansbury was on Stansbury's Island, now, owing to the subsidence of the water-level, become a promontory projecting into the lake from the south shore.

utahensis. One of these, that upon which the Montana records have been based, differs also in its smaller flower and less numerous leaflets (7-9); it is treated here as *A. Purshii* var. *concinnus*. The other, from western Nevada, separated from true *utahensis* by a gap of some two hundred miles and the not insignificant barrier of the Humboldt and Carson sinks with their attendant volcanic mountains, has again a shorter flower and shorter calyx-teeth (cf. *A. Purshii* var. *tinctus*). Should these be included in *A. utahensis*, even as varieties, it would be impossible to separate the species, thus extended, from *A. Purshii*, the only character remaining being that of density of vesture, scarcely specific. By the exclusion of these extraneous elements, however, we are left with a relatively constant species marked by good carpological and distributional characters, always celarly defined from even the most tomentose, purple-flowered forms of *A. Purshii*. As here understood, *A. utahensis* is no longer separable from *A. Purshii* by the character of the pubescence, which, though commonly used in keys, proves not to be diagnostic, but on the more fundamental fruiting criteria which have passed unnoticed hitherto.

Otherwise the species has been well understood. Gandoger's fma. *umbellulata*, as shown by study of parts of the type-collection (A. Nelson No. 4514), does not differ significantly from the prevailing, more robust form; congested individuals with small leaflets and few-flowered racemes occur quite commonly throughout the range of the species.

21. ASTRAGALUS CALLITHRIX Barneby

Astragalus callithrix Barneby, Leafl. West. Bot. **3**:103, Tab. 1, fig. C. 1942.

Caulescent perennial, flowering the first year, with one-several erect or assurgent white-tomentose stems 1-6 (12) cm. long, rising from the summit of a slender vertical root; herbage densely white-pubescent with a vesture of appressed or ascending, sinuous and somewhat matted hairs, scarcely or not at all sericeous; stipules triangular, acute or acuminate, 2-5 mm. long, white-tomentose, nowhere imbricated; leaves (1.5) 3-6 (12) cm. long, the slender, deciduous petioles somewhat shorter than the rachis; leaflets 9-21, broadly obovate to suborbicular, 2-8 (12) mm. long; racemes 8-14-flowered, 1-1.5 cm. long in flower but becoming looser and 2-4 (8) cm. long in fruit, on stout, erect or ascending peduncles (1.5) 3-7 (14) cm. long; calyx purplish, pubescent with loosely ascending white hairs, the tube 5-8 mm., the subulate teeth 1-2 mm. long; corolla bright purple, the banner 17-23 mm., the wings 18-21 mm., the keel 12-20 mm. long, the blades of the latter gently arcuate into the very obtuse apex; pod very obliquely lance-ovoid, arcuate, especially above the middle, through about half a circle into the laterally compressed deltoid beak, elsewhere strongly obcompressed, obtuse at base, 10-13 mm. long and about 6 mm. in greatest diameter, dorsally sulcate but the ventral suture somewhat prominent and rarely depressed, the valves thinly coriaceous, finely reticulate, 0.1-0.2 mm. thick, not tomentose but rather thinly villous-hirsute with silky, spreading hairs about 2 mm. long; seeds (immature) yellowish-brown, about 2 mm. long.

Type-locality.—Seven miles south of Callaway, Nevada; collected by H. D. Ripley & R. C. Barneby in 1941.

Distribution.—Sand-dunes on the floor of sagebrush valleys in northern Nye County, Nevada, alt. about 5100 ft.

Exsiccata.—NEVADA. *Nye Co.:* S. of Callaway, Ripley & Barneby No. 3631 (CAS, type). E. of Warm Springs, No. 4434 (CAS, G).

Astragalus callithrix was compared in the original diagnosis with *A. utahensis* and *A. nudisiliquus*, from both of which it differs in the size, texture and pubescence of the fruit, the less cottony and matted vesture of the entire plant, the erect (or at least not reclining) peduncles, and the slender, short-lived root. It should perhaps also have been contrasted with *A. inflexus*, not unlike it in the strongly arcuate pod and at length elongating racemes, but lacking the long, setaceous-tipped calyx-teeth and stipules of that species, and its loose arachnoid pubescence.

The species seems to be localized in central Nevada, where it has been found only in deep sand-dunes which occur here and there on the floor of the elevated sagebrush valleys. In both of the known stations, which lie approximately fifty miles apart, the Astragalus is associated with the commoner, but also endemic, *Cymopterus Ripleyi* Barneby.

22. ASTRAGALUS OPHIOGENES Barneby

Astragalus ophiogenes Barneby, Leafl. West. Bot. 4:232. 1946.

Subacaulescent, or with several evident, prostrate, villous-tomentose stems 2-8 cm. long, clustered on the summit of a taproot, forming low, tufted plants; herbage villous throughout with loose, tortuous, fine and tangled, basifixed hairs, canescent or becoming greenish; stipules triangular to lanceolate, acute or acuminate, (5) 7-12 mm. long, the upper sometimes with threadlike tips; leaves (2) 4-11 cm. long, the rachis somewhat exceeding the petioles, which persist feebly about the root-crown; leaflets (7) 11-17, narrowly (rarely broadly) obovate to elliptic, acute or obtuse and mucronulate, occasionally subemarginate at apex, 5-12 mm. long; peduncles either shorter than or slightly exceeding the leaves, striate, erect at anthesis, reclinate in fruit; racemes (3) 7-11-flowered, rather loose, becoming (1) 2-4 cm. long; calyx membranous, purple-tinged, the cylindric tube 5-6 mm., the subulate to narrowly triangular teeth (0.7) 1-1.5 mm. long; corolla purple, the banner 13-14 mm., the wings about 13 mm., the keel 10.5-11.5 mm. long; pod obliquely ovoid, obtuse and strongly obcompressed below, arcuate upward through one to two thirds of a circle into the deltoid, pungently acute beak, 8-11 mm. long, 5-7 mm. in greatest diameter, the ventral suture strongly sulcate toward the base but prominent above, the dorsal slightly sulcate and the section subdidymous below the middle, the valves leathery, obscurely reticulate, villous with rather coarse, spreading, silvery hairs 2-3 mm. long, the vesture almost concealing the surface, but not the shape, of the valves; seeds greenish-black, 2.3-2.5 mm. long.

Type-locality.—At the foot of a volcanic mesa, east of King Hill, Elmore County, Idaho; collected by H. D. Ripley & R. C. Barneby in 1945.

Distribution.—Dunes and sandy gulches along the Snake and lower Bruneau rivers in southwestern Idaho.

Exsiccata.—IDAHO. *Elmore Co.:* E. of King Hill, Ripley & Barneby No. 6478 (CAS, type, G, NY, Poc). *Owyhee Co.:* Bruneau, Jones No. 25408, 25435 (PO).

As shown in the original diagnosis, *A. ophiogenes* resembles both the preceding in its small, relatively thinly shaggy pod, and *A. Purshii* var. *glareosus* in the ventrally sulcate pod and the arachnoid quality of its pubescence. From the former it is quickly distinguished by the arachnoid and much finer, more tangled vesture, by the firm texture of the pod, and the stronger, cespitose root-stock; and from all forms of var. *glareosus* by its much shorter calyx and corolla. It is probably most nearly related, however, to the latter.

23. ASTRAGALUS NUDISILIQUUS A. Nels.

Astragalus nudisiliquus A. Nels., Bot. Gaz. **54**:410. 1912; Peck, Leafl. West. Bot. **4**:182. 1945. *Xylophacos mudisiliquus* (A. Nels.) Rydb., Bull. Torr. Bot. Cl. **52**:368. 1925; N. Amer. Fl. **24**:303. 1929.

A. inflexus var. *glareosus* sensu Jones, Rev. Astrag. 221. 1923, pro parte; non *A. glareosus* Dougl.

Xylophacos utahensis sensu Rydb., Fl. Rocky Mts. 506. 1917, pro parte, e syn.; non alibi.

Caulescent, the herbaceous tomentose-canescent stems prostrate or reclining, (2) 5-15 (30) cm. long, rising from the summit of a taproot, forming low, loosely matted plants; herbage densely cottony-pannose or arachnoid-villous with fine, more or less matted and curly, basifixed hairs; stipules discrete, deltoid-acuminate, 2-5 mm. long, without threadlike tips; leaves 3-10 cm. long, the wholly deciduous petioles about half the entire length; leaflets (7) 11-15, narrowly or broadly obovate, obtuse or shortly acute, 4-11 mm. long, equally pubescent on both faces; racemes 4-6-flowered, 1-1.5 cm. long, on stout and at length reclinate peduncles 1-4 cm. long; calyx membranous, purple-tinged, the tube (9) 10-12 mm., the subulate teeth 2-3 mm. long; corolla pink-purple, the broadly oblanceolate, emarginate banner 20-24 mm., the wings 20-22 mm., the keel 18-21 mm. long; pods very obliquely ovoid, cuneate at base or narrowed into a short, necklike pseudostipe above the insertion, strongly arcuate above into the acute or acuminate beak, (1.5) 2-3 (4) cm. long and 8-12 mm. in greatest diameter, dorsiventrally compressed except toward the apex, sulcate ventrally but not or scarcely so dorsally, the valves at first green and fleshy, becoming castaneous and woody when dry, 0.5-1 mm. thick, obscurely rugulose but commonly with several fine, sharp, longitudinal ridges or wrinkles on either side of the ventral suture, not tomentose but rather thinly villous-hirsute with spreading, tortuous white hairs 1.5-2.5 mm. long; seeds dark green or nearly black, about 2.5 mm. long.

Type-locality.—On the steep cobblestone bluffs of the Snake River at King Hill, Idaho; collected by Aven Nelson & J. Francis Macbride in 1911.

Distribution.—Sandy or gravelly bluffs along the Snake, Bruneau and Malheur rivers in southwestern Idaho and adjacent Oregon, alt. 2100- 3500 ft.

Exsiccata.—IDAHO. *Elmore Co.:* King Hill, Nelson & Macbride No. 1088 (G, isotype). *Owyhee Co.:* 14 miles SW. of Bruneau, Ripley & Barneby No. 6532 (CAS). SE. of Hot Springs, No. 6513. Bruneau, No. 6484 (CAS, Poc). *Payette Co.:* SE. of Payette, No. 6544 (NY). OREGON. *Malheur Co.:* Hillsides of the Malheur region, Cusick No. 1951a (G, without locality, PO). Ontario, banks of the Snake

River, Leiberg No. 2003 (NY, PO). Harper (or Harper's Ranch), No. 2243, Ripley & Barneby No. 6121 (CAS, G), Peck No. 21317 (CAS).

The specimens from which the description of *A. nudisiliquus* was drawn were collected in mid-July, when the flowers had fallen, and the pubescence, as happens in other members of the *Argophylli*, had become whiter and more cottony than is usual at an earlier season. Jones claimed that it was no more than an aged individual of *A. inflexus* var. *glareosus* in which "decay had loosened the hairs on the pods . . . leaving the skin smooth." Nelson himself suggested that the pod was "probably at first white woolly-hirsute, the indument at length deciduous . . .," but in my gatherings from Oregon and Idaho the valves are thinly hirsute from the beginning, never tomentose or woolly, and this seems characteristic of the species. *Astragalus nudisiliquus* does not at all resemble *glareosus* but, as pointed out by Nelson and later stressed by Rydberg, has the aspect of, and is doubtless related to, *A. utahensis*, from which the broader, strongly arcuate-beaked and more woody pod distinguish it sharply. The stipules also are shorter and lack the threadlike tips commonly found in *A. utahensis*.

Rydberg, associating with the fruiting type the Leiberg and Cusick collections from Oregon, provided the first description of the flower, but erred in describing the petals as white. It is impossible to determine now, from their faded condition, the color of the corolla in these early gatherings. However, at Harper, Oregon, one of the localities visited by Leiberg, the species is quite abundant and, according to my personal observations, always purple-flowered. The specimens obtained there, at the time of writing but a few months old, have already lost almost all their color.

24. ASTRAGALUS INFLEXUS Dougl.

Astragalus inflexus Dougl. ex Hook., Fl. Bor.-Amer. **1**:151. 1831; Don, Gen. Hist. **2**:256. 1832; Gray, Proc. Amer. Acad. **6**:212. 1864; Wats., Bot. King 440. 1871; Proc. Amer. Acad. **22**:472. 1887; Jones, Zoë **4**:269. 1893; Cont. W. Bot. **10**: Pl. 4. 1902; Rev. Astrag. 220, Pl. 54. 1923; Sheld., Minn. Bot. Stud. **1**:145. 1894; St. John, Fl. SE. Wash. 219. 1937; Peck, Man. Pl. Oreg. 445. 1940; Abrams, Ill. Fl. Pac. St. **2**:577, fig. 2802. 1944. *Tragacantha inflexa* (Dougl.) O Kze., Rev. Gen. 945. 1891. *Phaca inflexa* (Dougl.) Piper, Cont. U. S. Nat. Herb. **11**:369. 1906. *Xylophacos inflexus* (Dougl.) Rydb., Bull. Torr. Bot. Cl. **40**:49. 1913; op. cit. **52**:366. 1925; Fl. Rocky Mts. 506. 1917; N. Amer. Fl. **24**:302. 1929.

Strongly caulescent, except in depauperate and vernal states, the several prostrate, zigzag stems (5) 10-35 (50) cm. long, radiating from the crown of a taproot; herbage villous throughout with fine, curly, arachnoid and basifixed hairs, commonly densely so and canescent, but sometimes thinly so and greenish; stipules deltoid to ovate-acuminate, often with threadlike tips, 6-16 mm. long, membranous with a green midrib; leaves spreading or ascending, 4-15 cm. long, the lower on petioles about equalling the rachis, the upper very shortly petiolate or subsessile; leaflets (9) 13-21 (27), obovate or elliptic, commonly cuneate at base and acute or abruptly acuminate at apex, those of the lower leaves sometimes obtuse, (4) 6-15 mm. long; peduncles stout, slightly shorter

than the leaf, in mature plants widely divaricate; racemes loosely 5-12 (15) -flowered, becoming (2) 3-9 cm. long in fruit; calyx villous, sometimes with some dark hairs, the cylindric tube 8.5-11 mm., the linear or lance-subulate, commonly setaceous teeth (3.5) 4-7 mm. long; corolla bright pink-purple, the oblanceolate banner 19-23 mm., the narrow wings 18-21 mm., the obtuse keel 15-18 mm. long; pod ovoid to lance-ovoid, 1.3-2.5 (3) cm. long, 6-8 mm. in greatest diameter, lunate to abruptly arcuate near the middle through half a circle, obcompressed through the lower half or more and the sutures, but especially the dorsal, depressed-sulcate and approximate within, passing upward into a deltoid or deltoid-acuminate, laterally compressed beak, the valves leathery, villous-hirsute with both curly and some straightish silky-villous hairs about 1.5 mm. long, these not hiding the shape of surface of the pod, the cross-section, at and below the middle, deeply obcordate to didymous; seeds dark olive-brown or at length black, 2.5-3 mm. long.

Type-locality.—On the barren sandy grounds of the Columbia, from the junction of Lewis and Clark's River to the mountains; collected by David Douglas.

Distribution.—Dry sandy or rocky places, on low hills or valley-floors, from eastern Washington, chiefly in the Palouse region, to northeastern Oregon, and through north-central Idaho to adjacent Montana.

Exsiccata (*selecta*).—IDAHO. *Idaho Co.:* Brush Creek, Snake River Canyon, Packard No. 383 (Poc). White Bird Bridge, Davis No. 3191 (Poc). *Lemhi Co.:* Middle Fork of Salmon, Romero No. 260-36 (Poc). *Nez Perces Co.:* Lower Clearwater River, Sandberg, Leiberg & MacDougal No. 9 (CAS, G, NY). Mouth of Salmon River, Eastwood No. 13330 (CAS). Clearwater, "Oregon," Spalding (G, probably from Lapwai Mission). MONTANA. *Broadwater Co.:* 20 miles S. of Helena, Hitchcock & Muhlick No. 11808 (RB). *Cascade Co.:* Sand Coulee and near the Belt River, Williams No. 746 (G). *Lake Co.:* Wild Horse Island, Flathead Lake, Jones in 1908 (PO). St. Ignatius Mission, MacDougal No. 285 (NY). *Lewis and Clark Co.:* Helena, Kelsey (PO). *Missoula Co.:* Fort Missoula, Hitchcock No. 1648 (CAS). Lo-Lo, Elrod No. 114 (NY). *Ravalli Co.:* Hamilton, Blankinship No. 671 (PO). OREGON. *Co. unknown:* Riparia, Jones in 1905 (CAS, G, NY, PO, W). *Umatilla Co.:* Near mouth of Umatilla River, Howell No. 42 (G). *Wallowa Co.:* Above Imnaha, Peck No. 17476 (NY, W). Horse Creek Canyon, Sheldon No. 8031 (NY). WASHINGTON. since loc., Brandegee No. 722 (G). *Garfield Co.:* Illia, Lake & Hull No. 665 (G). *Spokane Co.:* Hangman Creek, Sandberg & Leiberg No. 18 (NY). *Whitman Co.:* Wawawai, Elmer No. 112 (NY, PO), St. John No. 5690 (G, NY). Almota, Piper No. 2938 (G, NY, PO, W). Lewiston Grade, Hitchcock & Muhlick No. 8379 (W).

Although no part of the type has been seen, the identity of the original *A. inflexus*, as understood by Gray, Jones and Rydberg, is fully confirmed by Hooker's excellent description and accompanying remarks. Its status as a species distinct from *A. glareosus* Dougl. (*A. Purshii* var. *glareosus* of the present revision) is somewhat less well established, in the light of modern collections. The characters stressed by Rydberg are not fully diagnostic. The calyx-teeth of *A. inflexus* are not always "nearly half the length of the tube," though this is commonly the case, while in var. *glareosus* they may be a little more than half, though usually much less. Likewise the pod is not always strongly incurved in *A. inflexus*, yet may be so occasionally in *glareosus*. Nev-

ertheless there is seldom any difficulty in placing specimens of either. In all but a few immature collections of *A. inflexus*, the stems and internodes are strongly developed and abruptly flexuous, with widely divaricate peduncles which do not become arcuate-reclinate in fruit, and the pod is narrower in proportion to its length and more deeply sulcate dorsally. Dwarfed or vernal forms of it, simulating var. *glareosus* in their loosely cespitose habit, may be recognized by the shortly petiolate or subsessile upper leaves, and by the nearly always long and setaceous calyx-teeth. Jones reduced *A. glareosus* to a variety of *A. inflexus*, but he was evidently influenced by his inclusion in the former of the strongly caulescent *A. nudisiliquus* (very distinct in the pod) which thus seemed to break down the most obvious and striking difference between the species. And at the same time he referred to *A. inflexus* the subacaulescent (Californian) form of *A. Purshii* with long calyx-teeth and ochroleucous flowers segregated by Rydberg as *Xylophacos incurvus*. When shorn of these alien elements, *A. glareosus* and *A. inflexus* become easier to define, even if they are not distinguished by any absolutely reliable single character. Though their relationship is undeniably close, it has not been generally realized that *A. inflexus* is considerably more distinct from *A. glareosus* than the latter from forms of *A. Purshii* (notably its var. *tinctus*), and if specific lines are to be drawn anywhere in the *Purshii-inflexus* group, *A. inflexus* itself has equal rights with *A. utahensis*, *A. leucolobus* and several others generally maintained as species.

The distribution of *A. inflexus* is partly coextensive with that of *A. Purshii* var. *glareosus*, particularly along the Columbia in Washington and Oregon, but I have no evidence that they occur together, and over large areas their ranges are disjunct. Along the Snake River above its confluence with the Salmon *A. inflexus* is wholly replaced by *glareosus*, while the latter extends much further northwestward in Washington, probably into British Columbia, and south into Nevada. Throughout the mountainous north and center of Idaho and over a considerable area in northwestern Montana *A. inflexus* is the only purple-flowered, villous-leaved member of the section. A recent report of the species from the southern slope of the Uinta Mts. in Utah (Graham, Ann. Carn. Mus. **26**:249. 1937) is almost certainly based on a misdetermination. It may be surmised that the cited collection (Graham No. 7573), not seen by me, represents the superficially similar *A. argophyllus* var. *pephragmenoides* native to the region.

25. ASTRAGALUS PURSHII Dougl.

Subacaulescent, the stems tufted on the summit of a taproot, or pulvinate with a heavy, branched caudex, or with evident, prostrate stems radiating from the root-crown, these forming depressed, circular mats; stems, when developed, densely white-tomentose, the growth of the year not exceeding 1 dm. in length; herbage arachnoid-villous or tomentose with fine, tortuous and matted hairs, strongly canescent or sometimes greenish, sericeous or cottony-pannose; stipules membranous, usually with a green midvein, ovate or ovate-acuminate, the upper often attenuate into threadlike tips; leaves 1-10 (15) cm. long, with

slender petioles about equalling the rachis and more or less persistent below as dark decaying tatters on the root-crowns or branches of the caudex; leaflets 3-19 (21), variable in shape, acute or obtuse, 3-15 mm. long; peduncles much shorter to longer than the leaves, arcuate-reclinate in fruit; racemes subcapitately 2-10-flowered, becoming 0.5-1.5 (3.5) cm. long in fruit; calyx villous or villous-tomentose, the tube long-cylindric to cylindro-campanulate, sometimes turgid, the teeth subulate to linear, from half as long as the tube to much shorter; corolla ochroleucous, whitish, lilac or brilliant purple, the banner moderately arcuate, the keel evidently shorter than the wings; pod obliquely ovoid, ovoid-oblong or ovoid-acuminate, obtuse at base, variously arcuate, about twice longer than broad (rarely less or more), obcompressed in the lower half and narrowed upward into a well-defined deltoid to deltoid-acuminate, laterally compressed beak, flattened to strongly sulcate dorsally and sometimes also ventrally, the cross-section ovate, ovate-cordate, transversely oblong and more or less constricted at either or both sutures, obcordate or didymous, the valves fleshy when first formed, becoming leathery, finely reticulate, entirely concealed by the dense shaggy vesture of tortuous and straightish, silky or cottony, white or at length yellowing hairs a little more to much less than half the pod's greatest diameter, or, very rarely, the vesture shorter and sparser, partially revealing the surface of the valves; seeds numerous, 2-3.5 mm. long, very dark brown or black, shining and often irregularly pitted.

Astragalus Purshii is an extremely variable species, consisting of many small races which are difficult or almost impossible to define in terms of key-characters. Numerous segregates within the species-group have been proposed, but their life in the literature has been short and obscure, since it is impossible to recognize them from the descriptions. The species, even in the broad sense accepted here, has numerous close allies, and it could well be extended even further to include *A. utahensis*, *A. ophiogenes* and perhaps *A. leucolobus* and *A. inflexus*, which are distinguished from some aspects of *A. Purshii* by relatively minor characters. The present arrangement is based on the principle of limiting *A. Purshii* to those evidently related plants in which the fruit is essentially alike in form and vesture, and excluding those which, while closely resembling it (or some segment of it) in pubescence, aspect and general structure, can be distinguished by some carpological peculiarity. Thus while *A. utahensis* can be separated finally from *A. Purshii* var. *tinctus* only by the narrower, nearly straight and long-silky legume, it has seemed convenient tc maintain it as a species, though it is probably no further removed in relationship from the ancestral *Purshii* stock than other races included in the present concept of the species. On the other hand *A. glareosus*, which I had thought to maintain on the character of the ventrally sulcate legume (the only character which distinguishes it finally from *A. Purshii* var. *tinctus*), is here subordinated to *A. Purshii*, since a ventral sulcus occurs, either occasionally or characteristically, in some of the other races of the species.

The following key to the varieties of *A. Purshii* must be used with caution, for it cannot be claimed that every specimen will be properly placed by following it. Many attempts to construct a more practical key have foundered on the

rock of the plants' inherent variability, and the characters emphasized are those prevailing in what are believed to be natural populations, but not necessarily found in every individual member. In some cases the indications of range are likely to be of greater service than the technical criteria.

KEY TO THE VARIETIES OF A. PURSHII

1. Flower relatively large, the calyx-tube and teeth together 10-15 mm. long, the keel (13) 14-19 mm. long or, if smaller, then the leaflets more than 9, at least in most of the leavse (2).
   2. Corolla ochroleucous or whitish with purplish-tipped keel, the banner rarely suffused with dull purple; widespread from northern California, central Nevada and northwestern Colorado to British Columbia and Saskatchewan ..... a. var. *typicus*
   2. Corolla purple or lilac-purple throughout; southern California to southwestern Montana and the Columbia Basin (3).
      3. Pod scarcely, if at all, sulcate ventrally near the base, though often so dorsally (4).
         4. Leaflets (5) 7-11 (13, or rarely to 17 in exceptional individuals); peduncles shorter than the leaves; White Mts., California, and adjacent Nevada, northward (5).
            5. Calyx narrowly cylindric at anthesis, not turgid, 2.5-3.5 mm. wide when pressed; banner relatively narrow; leaflets arachnoid-villous, if pannose then acutish or mostly more than 9 in number; along the easterly foothills of the Sierra-Cascade axis from the Columbia River southward ..... b. var. *tinctus*
            5. Calyx turgid at anthesis, 4-4.5 mm. wide when pressed; banner relatively broad; leaflets 7-9, commonly broadly ovate to suborbicular, cottony-pannose; central Idaho to adjacent Montana ..... c. var. *concinnus*
         4. Leaflets (9) 11-17 (19); peduncles longer than or equalling the leaves; southern California, on the Mohave Desert and about the San Joaquin Valley..... f. var. *longilobus*
      3. Pod strongly sulcate ventrally toward the base, the sutures there contiguous within. Columbia Basin to central Nevada (6).
         6. Flower relatively large, the keel (16) 17-25 mm. long; pod 1.5-2.5 cm. long (or rarely some on a plant shorter); seeds 2.9-3.5 mm. long; northeast Nevada and northward ..... d. var. *glareosus*
         6. Flower relatively small, the keel 12-15 mm. long; pod 10-13 mm. long; seeds about 2.5 mm. long; central Nevada ..... e. var. *pumilio*

1. Flower relatively small, the calyx-tube and teeth together (5) 6-9 (11) mm. long, the keel 8-13 (14) mm. long; leaflets relatively few, (3) 7-9 (13), mostly obovate and obtuse; southern Oregon to the California North Coast Range and southward along the Sierra (7).
   7. Pod moderately arcuate, the ventral suture usually nearly straight below, abruptly upcurved in the beak; North Coast Ranges and easterly crests and slopes of the Sierra Nevada in California; perhaps also in southern Oregon ..... g. var. *lectulus*
   7. Pod strongly arcuate throughout, usually through more than half a circle; plains of eastern Oregon and adjacent California ..... h. var. *lagopinus*

25a. var. typicus, nom. nov.

Astragalus Purshii Dougl. var. *typicus* Barneby, nom. nov. *A. Purshii* Dougl. ex Hook., Fl. Bor.-Amer. **1**:152. 1834; T. & G., Fl. N. Amer. **1**:336. 1838; in Beckwith, Pac. RR. Rep. **2**:120. 1855; Gray, Proc. Amer. Acad. **6**:212. 1863; ap. Brew. & Wats., Bot. Calif. **1**:151. 1880; Wats., Bot. King 72, 440. 1871; Proc. Amer. Acad. **22**:472. 1887, pro parte; Jones, Zoë **4**:268. 1893; Cont. W. Bot. **10**: Pl.

5. 1902; Rev. Astrag. 222, Pl. 55. 1923; Sheld., Minn. Bot. Stud. **1**:145. 1894; A. Nels., Bull. Wyo. Exper. Sta. **28**:97. 1896; Coult. & Nels., Man. 287. 1909; Jeps., Man. Calif. 572. 1925, pro parte; Fl. Calif. **2**:359. 1936; Tidestr. Cont. U. S. Nat. Herb. **25**:329. 1925, exclus. syn.; Graham, Ann. Carn. Mus. **26**:250. 1937; St. John, Fl. SE. Wash. 219. 1937; Peck, Man. Pl. Oreg. 445. 1940; Abrams, Ill. Fl. Pac. St. **2**:577, fig. 2806. 1944. *Tragacantha Purshii* (Dougl.) O. Kze., Rev. Gen. 947. 1891. *Phaca Purshii* (Dougl.) Piper, Cont. U. S. Nat. Herb. **11**:368. 1891. *Xylophacos Purshii* (Dougl.) Rydb., Bull. Torr. Bot. Cl. **32**:662. 1906; op. cit. **52**:368. 1925; Fl. Rocky Mts. 506. 1917; N. Amer. Fl. **24**:304. 1929; Fl. Prair. Pl. 474. 1932.

Phaca mollissima Nutt. ex. T. & G., Fl. N. Amer. **1**:350. 1838; Hook., Journ. Bot. **6**:214. 1847; non *Astragalus mollissimus* Torr.

Astragalus Purshii Dougl. var. *interior* Jones, Rev. Astrag. 222, Pl. 55. 1923.

Xylophacos incurvus Rydb., Bull. Torr. Bot. Cl. **52**:366. 1925; N. Amer. Fl. **24**:303. 1929. *Astragalus Purshii* var. *incurvus* (Rydb.) Jeps., Fl. Calif. **2**:360. 1936. *A. incurvus* (Rydb.) Abrams, Ill. Fl. Pac. St. **2**:577, fig. 2803. 1944; non *A. incurvus* Desf. (1800).

Subacaulescent, with several crowns clustered on the summit of a taproot, or with developed, prostrate, villous-tomentose stems up to 1 dm. long, rising from the divisions of a matted caudex; leaves 1.5-9 (15) cm. long; stipules 5-11 mm. long; leaflets (5) 9-13 (17), prevailingly elliptic to oblanceolate and acute at both ends, but often oblong-oval to obovate, rounded at apex or mucronate, (3) 5-12 (16) mm. long; peduncles shorter than the leaves; calyx villous, often (particularly on the teeth) with dark hairs, the cylindric tube 9-13 mm., the subulate or linear teeth 2-5 (7) mm. long; corolla ochroleucous or whitish, but the keel purple-tipped and the banner often veined or suffused with dull purple; banner 19-26 mm., wings 16.5-21 mm., keel (13) 15-18.5 mm. long; pod nearly straight to moderately or sometimes strongly arcuate, 1.2-2.3 cm. long, 5-9 mm. in greatest diameter, the valves concealed by the vesture of hairs 2-4 (5) mm. long.

Type-locality.—On the low hills of the "Spokan" River, Northwest America (i. e. in Lincoln or Spokane County, Washington); collected by David Douglas.

Distribution.—Hillsides, valleys and prairies, on exposed ridges in the mountains or in sandy pinewoods, but commonly associated with sagebrush, from interior British Columbia to Alberta and (fide Rydb.) Saskatchewan, south to northeastern California, central Nevada, northern Colorado and the Dakotas.

Exsiccata (selecta).—STATE UNKNOWN. Rocky Mts., Nuttall (G, isotype of *Phaca mollissima*, NY, P, named "*A. argophyllus*" in Nuttall's hand, the determination corrected by Gray). ALBERTA. Medicine Hat, Macoun No. 4207 (G). BRITISH COLUMBIA. Fraser River Valley, No. 443 (G, NY). Nicola Valley, Dawson No. 4315 (NY). CALIFORNIA. Sine loc. (probably in Sierra Co.), Lemmon No. 75 (NY. type of *Xylophacos incurvus*), No. 71 (NY). *Lassen Co.:* Doyle Station, Eggleston No. 6711 (G). W. of Susanville, Ripley & Barneby No. 5741 (CAS). Omira, Eastwood & Howell No. 8352 (CAS). *Plumas Co.:* Portola, Eastwood No. 7000 (CAS). *Sierra Co.:* Loyalton, No. 7861 (CAS). Sierraville, Ripley & Barneby No. 4528 (CAS, G). *Siskiyou Co.:* Fall River Valley, J. T. Howell No. 12227 (CAS). COLORADO. *Rio Blanco Co.:* S. of Rangeley, Ripley &-Barneby No. 5490. 25 miles E. of Rangeley, No. 7781. IDAHO. *Bannock Co.:* Red Hill near Pocatello, Cronquist No. 2267 (Poc). *Butte Co.:* N. of Leslie, Hitchcock & Muhlick No. 8863 (W). *Clark*

Co.: Medicine Lodge Creek, Davis No. 3161 (Poc). *Fremont Co.:* W. of St. Anthony, Quayle No. 12 (PO). MONTANA. *Broadwater Co.:* Between Townsend and White Sulphur Springs, Hitchcock & Muhlick No. 11848 (RB). *Deer Lodge Co.:* Anaconda, Jones in 1906. *Gallatin Co.:* Bridger Mts., Rydberg & Bessey No. 4497 (NY). *Granite Co.:* E. of Drummond, Hitchcock & Muhlick No. 11768 (W). *Missoula Co.:* Missoula, Elrod No. 29 (NY). *Petroleum Co.:* W. of Mosby, Ripley & Barneby No. 8234. *Powell Co.:* 16 miles W. of Ovando, Hitchcock & Muhlick No. 11575 (RB, W). NEVADA. *Elko Co.:* E. of Wells, Eastwood & Howell No. 322 (CAS). N. of Currie, Ripley & Barneby No. 6447 (NY). *Esmeralda Co.:* Mt. Gabb, Purpus No. 5867 (PO). Mt. Magruder, Alexander & Kellogg No. 2443 (NY). *Eureka Co.:* Emigrant Pass, Ripley & Barneby No. 4574 (CAS). *Nye Co.:* Toquima Range near Round Mountain, No. 3667 (CAS). Currant Creek, No. 3545. *Ormsby Co.:* Carson City, Anderson No. 77 (G, NY). Empire City, Jones No. 3830 (CAS, NY, PO). *Pershing Co.:* Trinity Mts., Watson No. 274 (G, NY). *White Pine Co.:* Aurum, Jones in 1893 (PO, type of var. *interior*, CAS, G, NY). OREGON. *Harney Co.:* sine loc., Cusick No. 2363 (G, PO). *Malheur Co.:* Owyhee, Leiberg No. 2158 (G). *Morrow Co.:* Lexington, No. 32 (G). *Union Co.:* Union, J. W. Thompson No. 4868 (W). *Wallowa Co.:* Lostine Canyon, Peck No. 17894 (PO, W). SOUTH DAKOTA. *Butte Co.:* Newell, W. P. Carr No. 14 (G, NY). WASHINGTON. since loc., Douglas (G, fragment ex herb. Hook., presumably authentic *A. Purshii* of Douglas). *Chelan Co.:* N. of Entiat, J. W. Thompson No. 6014 (G, W). *Grant Co.:* Grand Coulee, No. 11499 (CAS, G, NY, PO, W). *Lincoln Co.:* S. shore of Spokane River, 5 miles above its mouth, H. T. Rogers No. 388 (CAS, PO). *Spokane Co.:* Spokane, Piper No. 2288 (G, NY, PO, W). Liberty Lake, Suksdorf No. 8544 (CAS, G, NY). *Stevens Co.:* Spokane River above its confluence with the Columbia, Sharsmith No. 4006 (W). *Yakima Co.:* 20 miles S. of Toppenish, J. W. Thompson No. 11420 (CAS, G,PO). WYOMING. *Albany Co.:* Laramie, A. Nelson No. 53 (G), 2906 (PO). *Carbon Co.:* W. of Parco, Ripley & Barneby No. 7733. *Crook Co.:* NW. of Hulett, Ownbey No. 594, 594a (NY, W). *Lincoln Co.:* W. of Kemmerer, Payson & Armstrong No. 3229 (G, PO). *Sheridan Co.:* Big Horn, Tweedy No. 2357 (NY). *Sweetwater Co.:* Leucite Hills, Merill & Wilcox No. 466 (G, NY). Granger, Jones in 1896 (PO). *Teton Co.:* Jackson Hole, Mrs. Cantelow in 1942 (CAS). *Uinta Co.:* Evanston, A. Nelson No. 4508 (PO). *Weston Co.:* Newcastle, Bates in 1896 (NY). *Yellowstone National Park:* Mt. Everts, A. & E. Nelson No. 5699 (G, NY, PO).

The typical variety of *A. Purshii*, distinguished from the rest principally by its pale, whitish or ochroleucous petals (but often more or less veined or suffused with dull purple), and from var. *tinctus* by no other diagnostic character, is considerably variable in stature, in the length of the corolla, in the relative length of the calyx-tube and teeth, and in the curvature and pubescence of the pod. Only a fragment of the original Douglas plant from the Spokane River (and that not certainly identified as isotypic) has been seen, a single flower with calyx-tube 10.5 mm. and teeth 4.5 mm. long, and this agrees fully with Hooker's description, except that the banner is by no means an inch and a half (over 3.5 cm.) long. But since the plant here treated is the only species which agrees in other particulars with the original character, there seems little doubt that the traditional concept of *A. Purshii*, as adopted by Gray who must have seen the type at Kew, and by succeeding botanists, is correct.

Most of the numerous modern collections of *A. Purshii* from the Spokane River valley represent the robust extreme of the species, with well-developed stems rising from a matted caudex, with long stipules and calyx-teeth about

half as long as the tube, similar to the Douglas flower mentioned above. At the opposite extreme of the scale of variation lies an acaulescent, dwarf and tufted plant, with shorter, closely imbricated stipules and calyx-teeth one quarter the length of the tube, to which belong *Phaca mollissima* Nutt. and *A. Purshii* var. *interior* Jones. No type of the latter was indicated by its author, but two specimens at Pomona (Aurum, Nevada, Jones, 4 May 1893, and Laramie, A. Nelson No. 2906) are annotated by Jones as var. *interior,* and bear an additional note to the effect that the figure of the variety in the Revision of Astragalus was prepared from them. Of the two I would choose Jones' own gathering as lectotype. This collection represents the common plant of arid situations, which occurs throughout the range of var. *typicus,* including the Columbia Basin, where Jones claimed that it was replaced by the more robust, "typical" (in his sense) form of the species. These two extremes, connected by a series of intergradient individuals, seem to arise in nature as response to conditions of soil, aspect and moisture. In Eureka County, Nevada, I have collected both in the same locality (No. 4574), the condensed "var. *interior*" on open hillsides, and the laxer form with long calyx-teeth in the shelter of sagebrush along the floor of a gulch nearby; while plants indistinguishable from the most congested phase of the dry interior ranges of Wyoming or Nevada occur also near Spokane, Washington (cf. Suksdorf No. 8544), and even among Jones' specimens from Aurum there are intermediate individuals. The caulescent phase from Washington, which can be very striking, has been interpreted by St. John (Fl. SE. Wash. 220. 1937) as a hybrid between *A. Purshii* and *A. inflexus;* but since individuals almost as extreme occur well outside the range of *A. inflexus,* there seems little likelihood of this proving to be the case. According to the description of Douglas' plant, it seems to accord with exactly typical *A. Purshii.*

Granted this inherent variability in var. *typicus,* it becomes difficult, if not impossible, to maintain the segregate *Xylophacos incurvus,* whether as a subspecies or variety. In his key to the *Glareosi* in the North American Flora, Rydberg set off this species from *X. Purshii* as having the calyx-teeth "nearly half" as opposed to "less than one third" as long as the tube. A few pages lower, the calyx of *X. Purshii* is described as having the 'tube 1 cm. long . . . the teeth . . . 5 mm. long," and that of *X. incurvus* as with "tube about 1 cm. long . . . the teeth . . . 5-7 mm. long." These measurements are correct for some specimens which he considered typical of each but can scarcely be called diagnostic. While Rydberg's key character stands contradicted in his own work, his concept *X. incurvus* does represent a small race, apparently confined to the eastern slope of the Sierra Nevada in northern California and adjacent Nevada. Plants from this area are for the most part distinguished by long calyx-teeth and more abruptly incurved pod, shaggy with slightly longer hairs (up to 5 mm. long) than commonly found elsewhere in the range of *A. Purshii.* But as it passes eastwards into the rain-shadow of the Sierra, and occasionally in the heart of its minor area (as near Susanville, California), the distinctive features, either separately or together, become blurred and diminished, and *incurvus* passes directly into *typicus.* After much hesitation it has seemed best

to reduce it completely, though it should perhaps rank as a fairly well-marked forma.

The name *A. Purshii* has been employed loosely and made to cover a much wider concept than admitted here to var. *typicus*. Only those references which could be positively identified are listed in the bibliography, but others are referred to elsewhere in the text. In general this binomial has stood for any member of the *Argophylli* with woolly pods, especially in the early literature of the genus.

25b. var. TINCTUS Jones

Astragalus Purshii Dougl. var. *tinctus* Jones, Zoë **4**:269. 1893, emend. in Rev. Astrag. 223, Pl. 56, exclus. sect. 1923; Zoë **5**:45. 1900; Cont. W. Bot. **10**: Pl. 5. 1902; Sheld., Minn. Bot. Stud. **1**:145. 1894; Jeps., Fl. Calif. **2**:359. 1936. *Phaca Purshii* (Dougl.) var. *tincta* (Jones) Piper, Cont. U. S. Nat. Herb. **11**:369. 1906.

A. candelarius Sheld., Minn. Bot. Stud. **1**:142. 1894; Tidestr., Cont. U. S. Nat. Herb. **25**:329. 1925, exclus. syn. plur.; Abrams, Ill. Fl. Pac. St. **2**:578, fig. 2808. 1944. *Xylophacos candelarius* (Sheld.) Rydb., Bull. Torr. Bot. Cl. **52**:370. 1925; N. Amer. Fl. **24**:305. 1929.

A. candelarius var. *exiguus* Sheld., op. cit. 143. 1894.

A. lanocarpus Sheld., op. cit. 144. 1894, pro parte.

Xylophacos subvillosus Rydb, Bull. Torr. Bot. Cl. **52**:370. 1925; N. Amer. Fl. **24**:304. 1929.

X. ventosus (Suksd.) Rydb., op. cit., 1925, p. 370; op. cit., 1929, p. 303. *Astragalus ventosus* Suksd. ex Abrams, Ill. Fl. Pac. St. **2**:578. 1944, in nota; Rydb., 11, citt., in syn.

Astragalus utahensis sensu Jones, Zoë **4**:269. 1893, quoad pl. descr.; non T. & G.

Subacaulescent or with matted caudex and evident stems; herbage thinly arachnoid-villous and greenish to densely cottony-pannose (as in *A. utahensis*); leaflets (5) 7-11 (13 or rarely 17), elliptic to obovate, acute to very obtuse; calyx villous with light and dark hairs in varying proportions, sometimes all dark, the tube 8-10 mm., the teeth 1.5-3 (3.5) mm. long; corolla bright purple, the banner 17-20 (22) mm., the wings 15-19 (20) mm., the keel (13) 14-17 (19.5) mm. long; pod obliquely ovoid with well-defined beak, 1.3-2.5 cm. long, 6-9 mm. in greatest diameter, moderately arcuate, flattened or sulcate dorsally, not or scarcely so ventrally, the valves densely villous with silky or cottony hairs 3-5 mm. long.

Type-locality.—Soda Springs, Nevada County, California; collected by M. E. Jones in 1881.

Distribution.—Mesas and dry slopes, easterly foothills of the Sierra Nevada in western Nevada and adjacent California, from the White Mountains northward to interior Oregon and the lower valley of the Columbia River.

Exsiccata (*selecta*).—CALIFORNIA. *Lassen Co.:* Dixey Valley, M. S. Baker in 1894 (PO). *Modoc Co.:* Parker Creek, Payne No. 424 (CAS). Pine Creek, Warner Mts., Ripley & Barneby No. 6037. *Nevada Co.:* Soda Springs, Jones in 1881 (PO, lectotype of var. *tinctus*). Road to Sierra Valley, Sonne No. 66, 23 May, 13 July 1886 (M, cotypes of *A. candelarius* var. *exiguus*). Truckee, Sonne, in 1887 and 1895 (NY). Hobart Mills, Ripley & Barneby No. 4516. *Plumas Co.:* Red Clover Valley, Heller & Kennedy No. 8727 (P). *Sierra Co.:* Sierra Valley, Lemmon in 1873 (NY, type of *Xylophacos subvillosus*, G). *Siskiyou Co.:* Yreka, G. D. Butler No. 1113 (PO). NEVADA. *Esmeralda Co.:* Palmetto Range, Purpus No. 5879 (PO). *Mineral Co.:*

Candelaria, Shockley No. 33, April, May 1888 (M, types of *A. candelarius* and *A. candelarius* var. *exiguus*). Hawthorne, Jones in 1907 (PO). *Ormsby Co.:* Empire City, Jones in 1892 (PO). *Washoe Co.:* Peavine Hills, Ripley & Barneby No. 4466 (CAS). Pyramid Lake, No. 4502. Lemmon Valley, Kennedy No. 2077 (P). Steamboat Springs, Sonne No. 1 in 1877 (G), Ripley & Barneby No. 4482, 5945. Between Carbon and Reno, Mrs. E. C. Wright in 1928 (CAS). OREGON. *Lake Co.:* Summer Lake, Eggleston No. 6803 (G). WASHINGTON. *Klickitat Co.:* E. of Bingen, Suksdorf No. 10662 (NY, type of *X. ventosus*). Bingen, Suksdorf No. 50, 5916 (NY).

The var. *tinctus* is a fluctuating and not easily defined entity, poised both morphologically and geographically between var. *typicus* and var. *lectulus*, and intergrading with both. From the former it is distinguished by its purple flower and often broader, obtuse leaflets, but the color of the petals is the only absolute criterion, and this tends to be invalidated by plants of the typical race in which the banner and wing-tips are suffused with dull purple. From the northerly, mat-forming phase of var. *lectulus* the longer petals and calyx alone separate it, and it is only by accepting an arbitrary limit that a dividing line can be drawn between them. It is interesting to note how the range of var. *tinctus* interfingers with those of var. *lectulus* and the closely allied var. *lagopinus*. The latter occupies a considerable territory in transmontane Oregon with var. *tinctus* to the north and south of it; while *tinctus* itself, ranging along the foothills of the Sierra in a narrow strip immediately to the east of var. *lectulus* (and mostly between it and var. *typicus*), forms, in the low part of the northern Sierra Nevada, an intrusion between the two major areas of var. *lectulus*, and there displaces it. The inference seems to be that all have arisen from a common origin, and that the small-flowered varieties *lectulus* and *lagopinus* represent as yet imperfectly segregated forms which have appeared in response to local conditions of altitude (in the first case) and desert climate (in the second).

In Washoe County, Nevada, the var. *tinctus* is exceptionally polymorphic, varying between a dwarf, cespitose plant with loosely villous, often acute leaflets and black-hairy, deeply cleft calyx, and a looser extreme with densely pannose, rounded leaflets, and white-villous calyx with short teeth, which simulates *A. utahensis* to a marked degree. It was first described by Jones (Zoë 4:269) under that name, and specimens of it were cited as *X. utahensis* by Rydberg. However, as Jones pointed out, the pod is that of *A. Purshii*, and its relationship is clearly with var. *tinctus*, to which it is connected by intergradient states. It is especially abundant on the sinter domes about the geysers at Steamboat Springs, where I have studied it in some detail. Here also belongs the fruiting element of *A. lanocarpus* Sheld. from Reno (M, without indication of date or collector), distributed under a California Academy label; but the type of that species as proposed by Sheldon seems to belong rather to var. *glareosus*.

Astragalus ventosus is somewhat puzzling, occurring as it does so far out of the main range of var. *tinctus*, yet not distinguishable by any character of importance. It was separated by Rydberg on the criteria of dark-hairy calyx, a common variation, if not actually the normal state, in var. *tinctus*, and the "somewhat larger pod," which is simply incorrect. In fact Rydberg described

the pod of *X. candelarius* as slightly larger than that of *X. ventosus* (cf. N. Amer. Fl., l. c.). The plants from the Columbia River are very densely villous and do have, in an indefinable way, a distinct facies, but I have been unable to find any detail of structure or pubescence which does not occur in var. *tinctus* further south. *Xylophacos subvillosus* is, I think, exactly var. *tinctus*. The corolla was described as "apparently ochroleucous," but it is impossible to be certain of the original color in Lemmon's now faded and rather imperfect type. The specimen could almost as well represent the phase of var. *typicus* which has been called *Xylophacos incurvus*, and which is known to occur in the pinewoods about Sierra Valley. In any case the type is a form of *A. Purshii*, and not of *A. utahensis*, to which Rydberg related it; and its reduction to the latter by Abrams, and hence the inclusion of that species in the flora of California, is certainly incorrect.

By a strict application of the type-principle, it might be claimed that the varietal epithet *tinctus* should properly belong to what is here called var. *lectulus*. The name was applied by Jones to a mixture of material, cited as follows: "Edgewood near Mt. Shasta and also Ventura County, Brandegee. Olancha and Keeler, Inyo County, Brandegee. Soda Springs, Nevada County, Jones in 1882, and intermediate forms at Austin, Nevada, 16 June 1882." The first of these is a specimen of var. *lectulus* as defined in this paper, the second, third and fourth are var. *longilobus*, the last is var. *pumilio*, and only the specimen from Soda Springs can be referred to what is here called var. *tinctus*. The variety was described simply as: "Leaves very broadly obovate, small; flowers purple. Otherwise as in the type." All but the first and last specimens cited by Jones (in which the corolla is much smaller than in var. *typicus*) agree pretty well with this diagnosis, and it seems to me that the type should be chosen from among them. In his subsequent treatment of var. *tinctus* Jones himself, at least by inference, excluded from it the small-flowered as well as the southern elements of the original, and the plant described and figured in the Revision of Astragalus ("flowers about 2 cm. long . . . most common at Soda Spring near Summit, Nevada Co., Cal.") corresponds only with the plant from Nevada County. Both Rydberg (N. Amer. Fl., sub *X. candelario*, l. c.) and Jepson (Fl. Calif., l. c.) have accepted this interpretation of var. *tinctus*, but without attempting to analyze the original concept. Following Jones' inferential choice, the element of the original which remained part of his reformed and emended var. *tinctus*, I have designated his collection from Soda Springs as lectotype. Jones himself seems never to have been very sure of the identity of his variety, and at one time transferred the name to *A. Newberryi*. In the Index to Plates of the Revision of Astragalus we learn that the pod-sections of var. *tinctus* on Plate 56 were taken from plants collected in Zion Park, Utah, and at Aurum, Nevada, and the last is there said to be the "type," although eastern Nevada is far out of the range of var. *tinctus* as given in the text. In his herbarium there is a set of specimens from Aurum from which I conclude that the drawing was made, but it certainly formed no part of the original var. *tinctus*. It is to Jones' misdetermination of specimens of *A. Newberryi* from the Providence Mts. in southeastern California that we

can trace the appearance of the name *A. Purshii* var. *tinctus* in Munz, Man. S. Calif. 266, whence it was taken into Jaeger's Desert Wildflowers.

25c. var. CONCINNUS Barneby

Astragalus Purshii Dougl. var. *concinnus* Barneby, Leafl. West. Bot. **4**:231. 1946.
Xylophacos utahensis sensu Rydb., Bull. Torr. Bot. Cl. **52**:367. 1925, pro parte; non *A. utahensis* T. & G.

Acaulescent or nearly so; herbage densely floccose-tomentose with fine, curly and matted hairs; stipules closely imbricated, ovate-acuminate, 3-5 mm. long; leaves 2.5-9 cm. long, the slender petioles about equalling the rachis; leaflets (3) 7-9, obovate or suborbicular to broadly elliptic, rounded or obscurely acutish at apex, rather thin, 6-17 mm. long; peduncles slightly shorter than the leaves; racemes loosely but very shortly 4-6-flowered; calyx purpurascent, the somewhat turgid tube 7-10 mm., the lance-subulate teeth 2-3 mm. long; corolla purple, the broad banner 19-20.5 mm., the keel 15-16 mm. long; pod 13-20 mm. long, 5-6 mm. in greatest diameter, moderately incurved, the valves concealed by the dense floccose vesture of silky-villous, tangled hairs about 2 mm. long.

Type-locality.—Challis, Custer Co., Idaho; collected by J. F. Macbride and E. B. Payson in 1916.

Distribution.—Sagebrush valleys and foothills about the Lost River, Lemhi and Bitterroot mountains of central Idaho and in adjacent southwestern Montana.

Exsiccata.—IDAHO. *Butte Co.:* N. of Leslie, Hitchcock & Muhlick No. 8868a (W). *Custer Co.:* Challis, Macbride & Payson No. 3224 (NY, type, CAS, G, PO). Between Dickey and Challis, Hitchcock & Muhlick No. 8910 (W). Big Lost River, 20 miles N. of Sun Valley, No. 8809 (CAS, W). NE. of Dickey, Cronquist No. 3057 (Poc). *Lemhi Co.:* Brazil's Ranch, Birch Creek, Davis No. 92-33 (Poc). Salmon, Payson & Payson No. 1764 (CAS, G, NY). S. of Lemhi, Hitchock & Muhlick No. 9206 (W). MONTANA. *Beaverhead Co.:* sine loc., Tweedy No. 12 (NY). Armstead, Payson & Payson No. 1909 (G, NY). Red Rock, Shear No. 3350 (NY). *Jefferson Co.:* Whitehall, Ripley & Barneby No. 8120 (CAS). *Silver Co.:* N. of Melrose, No. 8131.

As stated in the original publication, the var. *concinnus* has the habit, pubescence and flower of *A. utahensis*, to which former authors have referred it, but the leaflets are fewer to the leaf, and, since the pod is precisely like that of *A. Purshii* var. *typicus* and var. *tinctus*, it seems impossible to maintain it as a distinct species. Although its subordination to *A. Purshii* weakens the characters by which the species, sensu lato, can be separated from *A. utahensis*, the form of the legume remains an excellent criterion.

25d. var. glareosus (Dougl.), comb. nov.

Astragalus Purshii Dougl. var. *glareosus* (Dougl.) Barneby, comb. nov. *A. glareosus* Dougl. ex Hook., Fl. Bor.-Amer. **1**:152. 1834; T. & G., Fl. N. Amer. **1**:333. 1838; Tidestr., Cont. U. S. Nat. Herb. **25**:329. 1925, pro parte; Peck, Man. Pl. Oreg. 445. 1940; Abrams, Ill. Fl. Pac. St. **2**:578, fig. 2807. 1944. *Tragacantha glareosa* (Dougl.) O. Kze., Rev. Gen. 945. 1891. *Astragalus inflexus* Dougl. var. *glareosus* (Dougl.) Jones, Cont. W. Bot. **10**:62, Pl. 5. 1902; Rev. Astrag. 221, Pl 54. 1923. *Phaca glareosa* (Dougl.) Piper, Cont. U. S. Nat. Herb. **11**:369.

1925. *Xylophacos glareosus* (Dougl.) Rydb., Fl. Rocky Mts. 506, 1063. 1917; Bull. Torr. Bot. Cl. **52**:369. 1925; N. Amer. Fl. **24**:305. 1929.
A. allanaris Sheld., Minn. Bot. Stud. **1**:141. 1894.
A. lanocarpus Sheld., op. cit. 144. 1894, quoad typ. *A. leucocystis* Greene, Erythea **3**:76. 1895.
A. Booneanus A. Nels., Bot. Gaz. **53**:223. 1921, pro max. parte.

Similar in habit, herbage, stipules and pubescence to var. *typicus;* calyx-tube 8-12 mm., the subulate to linear teeth (1.5) 2-4.5 (6) mm. long; corolla as in var. *tinctus*, purple, the banner 18-25 (29) mm., the wings 21-24 (25) mm., the keel (16) 17-19 (21.5) mm. long; pod lunate to very strongly arcuate toward the middle or obscurely sigmoid in outline, (1.2) 1.8-2.5 cm. long, 7-10 (12) mm. in greatest diameter, strongly obcompressed through the lower half (or at least toward the base), abruptly passing upward into the commonly much incurved beak, strongly sulcate ventrally, at least below the middle, less or scarcely so dorsally, but the dorsal suture sometimes narrowly inflexed as a narrow partial septum, the sutures approximate within and the cross-section cordate or 8-shaped, the valves either densely floccose-tomentose with tangled hairs up to 2.5 mm. long, or but densely villous with hairs only 1 mm. long, the vesture then not quite concealing the surface of the valves; seeds 2.9-3.5 mm. long.

Type-locality.—Plentiful on dry gravelly banks of rivers, from the confluence of Lewis and Clark's River with the Columbia and the mountains; collected by David Douglas.

Distribution.—Sterile hillsides, commonly with sagebrush, southern Idaho, particularly in the Snake River valley, to interior Oregon and Washington, northeastern Nevada, and reported from British Columbia. Records from Wyoming, Utah and Montana are based on related species.

Exsiccata (*selecta*).—Sine loc., Douglas (G, fragment of type, presumably from either Walla Walla Co., Wash., or Umatilla Co., Ore.). IDAHO. *Boise Co.:* E. of Lowman, Hitchcock & Muhlick No. 8603 (CAS, W). *Butte Co.:* Arco, Davis No. 159 (Poc). *Canyon Co.:* Caldwell, Boone No. 2 (PO, photo of type of *A. Booneanus*), A. Nelson in 1910 (PO). Falk's Store, Macbride No. 57 (G, NY, PO, cotypical collection of *A. Booneanus*). *Elmore Co.:* Dixie, Macbride & Payson No. 2850 (G). *Gem Co.:* Emmett, Macbride No. 785 (G, NY). *Owyhee Co.:* Crow's Nest, Davis No. 6-37 (Poc). *Washington Co.:* Weiser, Jones No. 6228 (NY, PO). Old's Ferry, Ripley & Barneby No. 6554. NEVADA. *Elko Co.:* Between Elko and Wells, Eastwood & Howell No. 281, 300 (CAS). OREGON. *Baker Co.:* Snake River Canyon near Gypsum, Ripley & Barneby No. 6567 (CAS). *Gilliam Co.:* Condon, Constance & Beetle No. 2697 (G, PO). *Grant Co.:* Prairie City to Blue Mts., Henderson No. 5102 (CAS). *Harney Co.:* E. of Stinkingwater Pass, Ripley & Barneby No. 6110 (CAS). *Malheur Co.:* Barren Valley, Leiberg No. 2202 (G). Rockville, Peck No. 20629 (CAS). *Umatilla Co.:* Pendleton, Jones in 1902 (PO). *Union Co.:* La Grande, Ben Bailey in 1926 (W). *Wasco Co.:* Canyon of Deschutes, Peck No. 14575 (W). WASHINGTON. *Chelan Co.:* Dryden, J. W. Thompson No. 6322 (W). *Franklin Co.:* Pasco, Kincaid & Hindshaw in 1896 (W). *Grant Co.:* Soap Lake, G. N. Jones No. 2846 (W). *Kittitas Co.:* Vantage, J. W. Thompson No. 8213 (NY, PO, W). Ginkgo State Park, H. W. Smith No. 246, 460, 2016 (W). *Klickitat Co.:* Klickitat Prairie, Howell in June, 1880 (M, type of *A. lanocarpus*, NY). Satus Pass region, J. W. Thompson No. 14290 (W). *Okanogan Co.:* Loomis, Jones in 1911 (PO). *Yakima Co.:* Rattlesnake Mt., Suksdorf No. 1811 (M, type of *A. allanaris*). North Yakima, Henderson No. 2356 (G, W).

Since *A. glareosus* is poised, as it were, in a gap between *A. Purshii* and *A. inflexus*, it becomes something of a problem to decide whether or not it should be maintained as species and, if not, to which species it should be subordinated. Although Jones reduced it to varietal status under *A. inflexus*, there is in reality seldom any difficulty in separating specimens of the two, in spite of the fact that the relative length of calyx-tube and teeth (the latter supposedly much shorter in *glareosus*), the character commonly used in keys, proves to be incompletely diagnostic. Jones seems to have been led astray by his inclusion in *glareosus* of Cusick's flowering material of the very different *A. nudisiliquus*, which, being strongly caulescent, seemed to invalidate as a criterion the presence of developed stems, perhaps the most striking feature of *A. inflexus*. In fact the elongate, strongly flexuous stems, long attenuate bracts and calyx-teeth, loose fruiting raceme and usually narrower and more strongly arcuate pod combine to distinguish quite sharply all but a few starveling or very immature specimens of *A. inflexus*. The difficulty in separating *A. glareosus* from *A. Purshii* is much greater. From the *tinctus* variety of the latter it can be distinguished only as the fruit matures, when the deep sulcus along the ventral suture and the subdidymous cross-section become apparent. Since a depressed groove may also be found (though rare, and less pronounced) in the pod of the ochroleucous-flowered *A. Purshii* var. *typicus*, there seem to be no solid grounds for maintaining it as a species apart.

Astragalus glareosus was described, from flowering material collected by Douglas, as "a very beautiful plant, scarcely 5 inches high, with densely woolly and whitish foliage . . . and . . . large flowers . . . of a rich purple-blue colour"; and since there is no other species now known to occur in the region travelled by Douglas which agrees with the character supplied by Hooker, it seems pretty certain that Jones' interpretation of it, as adopted here, was the correct one. Moreover the fragment of Douglas' plant in herb. Gray (mounted on the type-sheet of *A. argophyllus* Nutt.) fully agrees with the common purple-flowered Xylophacos of the upper Columbia and Snake River valleys.[12] The true *A. glareosus* suffered a long eclipse between 1840, when Hooker & Arnott referred to it a specimen of *A. argophyllus* collected by Tolmie in the Snake Country, and its revival by Jones in 1902. During this period the name was employed chiefly (by Gray entirely) for *A. argophyllus*, and also, on occasion, for other similar and related plants. Even Rydberg, in his monograph of *Xylophacos*, failed to extricate it completely from *A. argophyllus*, since he referred to it the more loosely pubescent phase of the latter which I have called var. *pephragmenoides*. And it was while under the impression that *A. glareosus* and *A. argophyllus* were synonymous that Sheldon and Aven Nelson described their *A. allanaris* and *A. Booneanus*. In the latter case some

12 In "The Journal of David Douglas," p. 63. 1914, an *A. glareosus* is mentioned as having been collected on the Columbia River, between Spokane and Kettle Falls, in April, 1826. This is still within the range of *glareosus* as understood here, but lies far north of the type-locality as published by Hooker. However it is stated in Flora Boreali-Americana that the specimens from which the description was drawn were collected in April and May, so there must have been two gatherings involved.

confusion still persisted, a small element of *A. Booneanus* being in reality *A. argophyllus* var. *pephragmenoides*. *Astragalus lanocarpus* (for which Greene substituted the linguistically purer *A. leucocystis*) seems to belong here rather than to *A. Purshii* var. *typicus*, to which Rydberg referred it. The species was based on indifferent material obtained by Thomas Howell in Klickitat County, Washington. No flowers remain on the type (M) but Sheldon described them as "ochroleucous tipped with purple," a phrase which well describes the color of many an originally bright purple flower after some years in the herbarium. The pod is ventrally sulcate, and this fact, coupled with the evidence of locality, leaves little doubt as to the identity of the species. Sheldon cited also a specimen from Reno, Nevada, which is to be referred with confidence to *A. Purshii* var. *tinctus;* so that *A. lanocarpus* was, at best, a mixed and doubtful entity.

While var. *glareosus* is always recognizable, when in fruit, by the ventrally sulcate pod, this varies considerably in length, somewhat less so in width, and to a quite surprising degree in the length and density of the vesture. Normally, i. e. throughout its range and, so far as known, always in Washington, the legume is as long and densely woolly as that of var. *typicus*, but here and there along the John Day and Malheur rivers in Oregon, and in adjacent Idaho, a form occurs with the pod clothed in relatively short and sparse villi about 1 mm. long. Examples of this are Howell No. 376, Macbride No. 57 and Ripley & Barneby No. 6117. The extreme state is striking, but intermediates occur.

Astragalus glareosus has been reported by Rydberg, on the basis of faulty determinations, from Lake County, Oregon, southern Montana and Wyoming, and from Cache County, Utah. Apparently very rare south of the Snake River Plains, it is replaced in central Nevada by

25e. var. **pumilio**, var. nov.

A. Purshii var. *tinctus* Jones, Zoë **4**:269. 1893, pro min. parte; non alibi.

A var. *glareoso* (Dougl.), cui caeterius praesimilis, corollae minoris carina 12-15 mm. tantum longa, legumine breviori 8-13 mm. longo, seminibusque minoribus circa 2.5 mm. longis recedens.

Similar in every way to var. *glareosus*, but smaller; calyx-tube 7-9 mm., the teeth 2.5-4 mm. long; corolla brilliant purple, the banner 16-18 mm., the wings about 16 mm., the keel 12-14 mm. long; pod sulcate ventrally in the lower half, but only 8-13 mm. long. the deltoid beak strongly incurved, the valves densely villous-hirsute; seeds 2.5 mm. long.

Type.—Foothills of the Toyabe Range, south of Grass Valley, Ripley & Barneby No. 5908 (Herb. Calif. Acad. Sci. No. 328031).

Distribution.—Hillsides and open ridges, commonly in sagebrush, between 6000 and 7000 feet altitude, locally abundant in the Toyabe and Desatoya mountains of central Nevada.

Exsiccata.—*Churchill Co.:* Carroll Summit, Desatoya Mts., Ripley & Barneby No. 5935. *Lander Co.:* S. of Grass Valley, No. 5908 (CAS). Austin, Jones in 1882 (PO). *Nye Co.:* Peavine Creek, S. end of Toyabe Range, Train (NY).

The var. *pumilio* differs from var. *glareosus* only in the smaller size of its parts, but this reduction is considerable, and its geographic isolation supplies further evidence of its distinctness. In fact it is more sharply set off from var. *glareosus* (with which it has the ventrally sulcate pod in common) than var. *lectulus* from var. *tinctus,* although standing in a similar relationship to it. Jones included his gathering in the original, mixed var. *tinctus,* but perhaps was puzzled by it, since he left it unnamed in his herbarium. Susbequently Munz referred it (in herb.) to var. *lectulus,* similarly small-flowered but with a very different pod.

25f. var. LONGILOBUS Jones

Astragalus Purshii Dougl. var. *longilobus* Jones, Zoë **4**:269. 1893; Cont. W. Bot. **10**: Pl. 5. 1894; Rev. Astrag. 223, Pl. 55. 1923; Sheld., Minn. Bot. Stud. **1**:145. 1894; Munz, Man. S. Calif. 266. 1935; Jeps., Fl. Calif. **2**:360. 1936.

A. consectus Sheld., Minn. Bot. Stud. **1**:143. 1894, pro parte, quoad typ.; Davids., Fl. S. Calif. 196. 1923. *Xylophacos consectus* (Sheld.) Rydb., Bull. Torr. Bot. Cl. **40**:49. 1913; N. Amer. Fl. **24**:306. 1929. *Astragalus leucolobus* subsp. *consectus* (Sheld.) Abrams, Ill. Fl. Pac. St. **2**:578, fig. 2809. 1944.

A. inflexus Dougl. var. *flocculatus* Jeps., Man. Calif. 573, fig. 564. 1925; Munz, Man. S. Calif. 266. 1935.

A. inflexus var. *ordensis* Jeps., 1925, l. c. *A. Purshii* var. *ordensis* (Jeps.) Jeps., Fl. Calif. **2**:360. 1936.

A. Purshii sensu Sheld. in Cov., Cont. U. S. Nat. Herb. **4**:87. 1893; Davids., Erythea **3**:155. 1895; non Dougl.

A. amphioxys sensu Sheld. in Cov., op. cit. 85. 1893; non Gray.

A. Purshii var. *tinctus* sensu Jones, Zoë **4**:269. 1893, pro parte; non alibi.

Xylophacos leucolobus sensu Rydb., Bull. Torr. Bot. Cl. **52**:371. 1925, pro parte.

Subacaulescent and cespitose or caulescent and mat-forming, the stems almost none to 12 cm. long; similar in every way to the var. *tinctus,* but the mature leaves with more numerous and often narrower leaflets, (9) 11-17 in number; peduncles either exceeding or (rarely) shorter than the leaves; calyx either long-villous or crisply tomentose, the tube (6) 7.5-9 mm., the teeth 1.5-3 (4) mm. long; corolla bright purple or sometimes pale, the banner 16-19 mm., the wings about 17 mm., the keel (12) 13.5-16.5 mm. long, the latter either much shorter than or nearly as long as the banner; pod (1) 1.5-2.5 cm. long, obcompressed in the lower half and either shallowly or deeply sulcate on the dorsal side, the suture occasionally introflexed as an obscure partial septum up to 1 mm. deep.

Type-locality.—Tehachapi, California; collected by T. S. Brandegee in 1884.

Distribution.—Hillsides and canyons, sometimes in open pinewoods, in the dry interior or desert mountains of southern California, from the San Carlos

Range to the mountains about the head of the San Joaquin Valley, and eastwards across the Mohave Desert to Death Valley.

Exsiccata (*selecta*).—CALIFORNIA. *Inyo Co.:* Panamint Mts., Coville & Funston No. 543 (NY). Road to Aguerreberry Point, Eastwood & Howell No. 7837 (CAS). Shepherd's Canyon, Argus Mts., Jones in 1897 (NY, PO). *Kern Co.:* Tejon Mts., Coville & Funston No. 1196 (M). Tehachapi, Eastwood No. 3230 (CAS, G, NY). Water Canyon, Tehachapi Mts., Abrams & McGregor No. 432 (G, NY). Hot Springs, Brandegee (PO). Piute Mt., SE. of Bodfish, L. Benson No. 4395 (PO). *Los Angeles Co.:* Tejon Pass, Parish No. 1890, in June 1897 (M, type of *A. consectus*), Pringle in 1882 (P). *San Benito Co.:* Griswold Creek, on road to New Idria, Abrams & Borthwick No. 7956 (PO). Mt. San Carlos, Brewer No. 783 (G). *San Bernardino Co.:* Granite Wells, Mohave Desert, Johnston No. 6490 (PO). *Ventura Co.:* Mt. Pinos, Munz No. 7014a (NY, PO), Ripley & Barneby No. 4087 (CAS). Griffins, Elmer No. 3995 (G, NY, PO). Chula Vista Camp, J. T. Howell No. 3834 (PO).

The var. *longilobus* is accepted here as covering a polymorphic aggregate of minor races which, although generally recognizable to the initiate, do not lend themselves at present to precise definition. In general the plant of the Mohave Desert (var. *flocculatus*, sensu stricto) is marked by its cespitose habit, peduncles equalling or more often exceeding the leaf, dark and long-villous calyx and brilliantly colored corolla; the teeth of the calyx vary in length from 1.5 to 3 or occasionally 4 mm., the extreme in this direction being the nomenclatural type of var. *longilobus*. The pod is not always so deeply sulcate dorsally as figured by Jepson, but more often the dorsal suture is merely depressed toward the base of the pod, and the cross-section there is oblong with a slight constriction at the sutures. It is, however, sometimes truly didymous, and the suture is occasionally introverted as a very narrow partial septum. In the mountains about the head of the San Joaquin Valley, although plants occur which are technically indistinguishable from the desert race, the common phase is less densely cespitose, forming loose, prostrate mats, the peduncles are relatively shorter, the calyx is more shortly villous-tomentose with the teeth often abbreviated and sometimes obtuse, and the petals become more nearly equal in length and paler in color. These variable populations, which pass into true *longilobus* by a series of intergrades, have been known as *A. consectus*, and are of special interest in that they combine, in varying degrees, the obliquely ovoid, shaggy, unilocular legume of *A. Purshii* with floral and vegetative characters of *A. leucolobus* of the desert-bordering mountains immediately to the southeast. While it remains to be proved experimentally, the morphological evidence suggests that in this area there has been at some period an infection of the heredity of var. *longilobus* by the vicariant *A. leucolobus*, and that the *consectus* phase represents a complex population of hybrid origin. Such is the uncertainty as to the true nature of the races involved in var. *longilobus* sensu lato, that it has seemed most prudent to unite them for the present under one name. This was Jepson's solution of a difficult problem, and his concept of var. *longilobus* (Fl. Calif. 2:360) is almost equivalent to that accepted here (i. e. ranging from San Benito County in the south Coast Range to the Panamints); but he continued to maintain a second desert race, var. *ordensis*. The type of this variety has not been seen, but the

other material referred to it by Jepson seems to be inseparable from var. *longilobus,* and I am quite unable to recognize two desert races.

All the collections available to Rydberg were at first (Bull. Torr. Bot. Cl. **52**:371) placed in his *Xylophacos leucolobus,* though it was noted that some diversity existed in the species thus formed. In the North American Flora he recognized a *X. consectus* as well as *X. leucolobus,* but failed to define either so that they could be recognized. The *X. consectus* of the Flora of the Rocky Mountains was based on part of the original mixture which Sheldon described as *A. consectus,* and which included elements of *A. Newberryi* and perhaps other related species. The actual type of *A. consectus,* as specifically stated by Sheldon, was Parish's plant from Tejon Pass. It represents the normal form of var. *longilobus* with calyx-teeth about 3 mm. long.

25g. var. LECTULUS (Wats.) Jones

Astragalus Purshii Dougl. var. *lectulus* (Wats.) Jones, Cont. W. Bot. **10**:61, Pl. 6. 1902; Rev. Astrag. 223, exclus. pl. oreg. Pl. 56. 1923; Jeps., Man. Calif. 272. 1925; Fl. Calif. **2**:360. 1936; Munz, Man. S. Calif. 471. 1935. *A. lectulus* Wats., Proc. Amer. Acad. **22**:471. 1887; Sheld., Minn. Bot. Stud. **1**:141. 1894; Abrams, Ill. Fl. Pac. St. **2**:578, fig. 2811, 1944, exclus. syn. *Xylophacos lectulus* (Wats.) Rydb., Bull. Torr. Bot. Cl. **52**:371. 1925; N. Amer. Fl. **24**:307. 1929.

Xylophacos argentinus Rydb., Bull. Torr. Bot. Cl. **52**:371. 1925; N. Amer. Fl. **24**:306. 1929; non *A. argentinus* Haum. *Astragalus* Jonesii Abrams, Ill. Fl. Pac. St. **2**:578, fig. 2810. 1944.

? *Astragalus Purshii* Dougl. var. *gavisus* Jeps., Fl. Calif. **2**:360. 1935.

A. Purshii var. *tinctus* Jones, Zoë **4**:269. 1893, pro parte, non alibi.

Xylophacos Purshii sensu Heller, Muhlenb. **2**:217. 1906; non Rydb.

Similar in every way to var. *tinctus,* but smaller, acaulescent or subpulvinate at great altitudes, becoming looser and matted in favorable situations; leaves 1-7 cm. long; leaflets (3) 5-11 (13), prevailingly oblanceolate to obovate and obtuse, sometimes elliptic and acute, 2-9 (12) mm. long; peduncles shorter than the leaves; calyx-tube (4.5) 5.5-8 (9.5) mm., the teeth 1-3 mm. long; corolla pink, occasionally whitish or bright purple, the banner 12-16 (19) mm., the wings 10-14 (17) mm., the keel 9-13 (14) mm. long; pod moderately arcuate to nearly straight except for the incurved beak, 7-15 mm. long, 4-7 (9) mm. in greatest diameter, usually sulcate dorsally and sometimes obscurely so ventrally, the valves densely villous-tomentose with hairs 2-3 mm. long.

Type-locality.—Common in sandy soil in Bear Valley, San Bernardino Mountains, at 6000 feet altitude; collected by C. C. Parry in 1876.

Distribution.—Sagebrush mesas, dry benches in open pinewoods, or on exposed ridges of the interior mountains of California, from the North Coast Range to Mt. Shasta, south along the Sierra Nevada to Inyo County and the San Bernardino Mts. and in the outlying ranges of the Sierra-Cascade axis in southern Oregon and adjacent Nevada.

Exsiccata (*selecta*).—CALIFORNIA. *Alpine Co.:* Carson Pass, Eastwood & Howell No. 8418 (CAS, G). *Inyo Co.:* Lone Pine, Jones in 1897 (G, type of *X. argentinus,*

PO). Foothills W. of Bishop, Heller No. 8318 (CAS, G, P). Independence Creek, Hall & Chandler No. 7303 (G). *Lassen Co.:* N. of Madeline, Ripley & Barneby No. 5983. *Madera Co.:* NW. of San Joaquin Mt., J. T. Howell No. 16619 (CAS, RB). *Mendocino Co.:* Buck Rock Ridge, Eastwood No. 15301. Anthony Peak, Eastwood & Howell No. 19772 (CAS, RB). *Mono Co.:* Sonora Pass, Brewer No. 1908 (G), Eastwood & Howell No. 7575 (CAS). Mt. Conness, Clausen No. 1658 (PO). Hot Creek region, Peirson No. 12442 (RB). W. of Benton, Ripley & Barneby No. 5898. Mammoth, No. 4074. *San Bernardino Co.:* Bear Valley, Parry in 1876 (G, type), Parish No. 1812, 2348 (NY). Baldwin Lake, Munz No. 10495 (PO). *Shasta Co.:* Fall River Mills, Bethel in 1923 (CAS). *Siskiyou Co.:* Yreka, Greene No. 713 (G, P). N. slope of Mt. Shasta, Babcock & Stebbins No. 1954 (G). Hornbrook, C. F. Baker No. 3557 (CAS). Marble Rim, Marble Mts., J. T. Howell No. 15055 (CAS). Humbug Mt., J. D. Butler No. 1283 (PO). NEVADA. *Washoe Co.:* SW. of Vya, Ripley & Barneby No. 6019. OREGON. *Harney Co.:* Above Suntex, Buck Mt., Henderson No. 8771 (CAS).

The var. *lectulus,* as here delimited, embraces all of the several small purple or pink-flowered races of *A. Purshii* in which the pod is neither very strongly arcuate nor deeply sulcate ventrally toward the base. It thus includes not only the densely cespitose and commonly acaulescent form which is the nomenclatural type, and which ranges from the variety's southern limit in the San Bernardino Mts. northward along the easterly crests of the Sierra nearly to Lake Tahoe, but also the more obviously caulescent, mat-forming plant prevailing in the North Coast Range and the Shasta region. The latter is often distinguished by its relatively longer calyx-teeth, 2-3.5 mm. (as opposed to 1-2 mm. in the Sierran plant) long, but there are numerous exceptions. The only useful criterion by which var. *lectulus* may be separated from var. *tinctus* lies in the shorter calyx and corolla, and here there is complete intergradation, some individual plants (e. g. Eastwood & Howell No. 1744, CAS, or Butler No. 1113, PO, both from Yreka, Siskiyou County, being as well referred to either (cf. under var. *tinctus*). Perhaps it would be better, or at least offer a truer picture of relationships within the *Purshii* group, to unite these two and keep the southern *lectulus* apart, but I can see no way in which it could then be maintained except by consideration of range. Jepson accepted most of the northern plants with small flowers as belonging to var. *lectulus,* but has described a var. *gavisus* from the same region. I have not seen the type of this (Scott River Valley, Siskiyou County, T. H. Gilbert), which is characterized as having small flowers (calyx-tube 4 lines, teeth 1½-2 lines, i. e. about 6 and 2-3 mm. respectively) and pods "strongly arcuate" or contradictorily, in the diagnosis "paulo arcuata." The description applies well to the looser, lowland *lectulus* of the Siskiyou-Shasta region, and is therefore referred here tentatively. In the foothills of Mt. Shasta the pod of var. *lectulus* is inclined to be more strongly arcuate than elsewhere (cf. Babcock & Stebbins No. 1954), and these individuals shade directly into var. *lagopinus.*

Like many species which find their home on the dry easterly slope of the Sierra Nevada, *A. Purshii* var. *lectulus* has a wide altitudinal range, and as it descends from the summit screes (up to 11,000 ft.!) to the desertic foothills and tablelands of Mono and Inyo counties, the pulvinate, alpine state passes insensibly into a form of looser growth, with broader and thinner leaflets and

slightly larger flowers and pods. In this the corolla, as also in the alpine ecotype, is occasionally pale pink or whitish, and this form has been segregated as *Xylophocas argentinus* (*A. Jonesii* Abrams). Near Benton, Mono County, the larger-flowered, laxer "*argentinus*" was found growing in close association with true, condensed and small-flowered *lectulus*, the former occurring in slightly richer soil or in the shelter of sagebrush. Together with Jones and Jepson I believe *argentinus* to be merely a state of *lectulus*, and unworthy of formal recognition.

25h. var. **lagopinus** (Rydb.), comb. nov.

Astragalus Purshii Dougl. var. *lagopinus* (Rydb.) Barneby, comb. nov. *Xylophacos lagopinus* Rydb., Bull. Torr. Bot. Cl. **52**:372. 1925; N. Amer. Fl. **24**:307. 1929. *Astragalus lagopinus* (Rydb.) Peck, Madroño **6**:134. 1941; Man. Pl. Oreg. 445. 1941.

Astragalus Purshii var. Jones, Cont. W. Bot. **10**: Pl. 6 (as to the small arcuate pod). 1902; Rev. Astrag. Pl. 56 (fig. at top left). 1923.

A. viarius Eastw., Leafl., West. Bot. **1**:178. 1935.

A. Purshii var. *lectulus* sensu Jones, Rev. Astrag. 223. 1923; Abrams, Ill. Fl. Pac. St. **2**:578. 1944; amb. pro parte, quoad pl. oreg., non *A. lectulus* Wats.

Caulescent, with many prostrate stems radiating from the taproot, forming circular leafy mats 8-25 (35) cm. broad; stems persistent below as a branched caudex, the growth of the year 2-6 cm. long; leaves 1.5-4 cm. long; stipules 4-6 mm. long; leaflets (3) 5-7, narrowly to broadly obovate, obtuse or obscurely emarginate, 5-10 mm. long; calyx-tube 4-5 mm., the subulate teeth 1-2 mm. long; corolla purple or pink, the banner 9-13 mm., the wings 9-10 mm., the strongly incurved keel 8-9.5 mm. long; pod very obliquely lance-ovoid, obcompressed and obscurely sulcate dorsally towards the base, acuminate upward and regularly arcuate through its entire length into three quarters or nearly a complete circle 6-9 mm. in diameter, the body about 4 mm. in greatest width, the valves concealed by the vesture of shining, flexuous hairs 2-3 mm. long.

Type-locality.—On plains, between Prineville and Bear Buttes, Crook County, Oregon; collected by J. B. Leiberg in 1894.

Distribution.—Sandy valleys, pumice plains and mesas east of the Cascade Range from central Oregon to northeastern California.

Exsiccata.—CALIFORNIA. *Modoc Co.:* Between Mammoth Cave and Lava Beds National Monument, Eastwood & Howell No. 8245 (CAS). W. of Alturas, Mrs. Cantelow in 1940 (CAS). OREGON. *Crook Co.:* Between Prineville and Bear Buttes, Leiberg No. 326 (NY, type, M, PO). SW. of Prineville, Ripley & Barneby No. 6644. Beaver Marsh, Cusick No. 2824 (G, M, NY, PO). *Deschutes Co.:* 7 miles N. of Bend, J. T. Howell No. 7171 (CAS, type of *A. viarius*). 5 miles below Bend, Peck No. 9745 (G). Cline Falls, E. Nelson No. 825 (G). NW. of Plainview, Ripley & Barneby No. 6652 (CAS, NY). *Klamath Co.:* S. of Chemult, Peck No. 21932 (CAS). *Lake Co.:* Fort Rock, Eggleston No. 6838 (G, NY). Laidlaw, Whited No. 3029 (G).

This diminutive variety, treated as a species by Rydberg and Peck, is closely related to var. *lectulus*, to which Jones, and more lately Abrams, have

reduced it. Rydberg separated it from the latter because of its "better developed stems and peduncles, longer bracts, fewer flowers and fewer leaflets," but these characters fall far short of being diagnostic. Even in its type-locality var. *lectulus* may have stems up to 5 cm. long, and peduncles 2 cm. long, both about average for var. *lagopinus;* the bracts vary within about the same limits in both; the flowers may be as many as seven to the raceme in var. *lagopinus* and as few as three in var. *lectulus;* while the leaflets are commonly seven in both, as indeed Rydberg himself (N. Amer. Fl., l. c.) described them. Nevertheless var. *lagopinus* does have a certain individuality of facies, a distinct geographic range, and, as brought out in the key, a characteristic legume, and it is on these characters that the variety is maintained. Where Rydberg obtained his idea of the pod of *X. lagopinus* is something of a puzzle, since his description of it is so far from accurate. The type lacks mature fruit, but in no specimen that I have seen could the developed legume be described as "1 cm. deep and slightly incurved." In fact the greatest diameter of the fruit, at or near the base, does not exceed 4 mm., and the pod is always so strongly incurved as to form at least three quarters of a circle. It seems likely that it was Rydberg's erroneous description which led to the publication of *A. viarius;* while representing the smallest extreme of the variety, it exhibits in every way the characteristic pod and aspect of var. *lagopinus*. The same error may also account, in part, for Jones' wild identification of *X. lagopinus* (Cont. W. Bot. **18**:45. 1935) with the wholly unlike and unrelated *A. Pulsiferae* Gray.

26. ASTRAGALUS LEUCOLOBUS Jones

Astragalus leucolobus Jones, Zoë **4**:270. 1893; Sheld., Minn. Bot. Stud. **1**:144. 1894; Davids., Fl. S. Calif. 195. 1923; Jeps., Fl. Calif. **2**:361. 1936; Abrams, Ill. Fl. Pac. St. **2**:578. 1944, exclus. fig. 2809. *A. Purshii* var. *leucolobus* (Jones) Jones, Cont. W. Bot. **10**:61, Pl. 5. 1902; Rev. Astrag. 223, Pl. 55. 1923. *Phaca leucoloba* (Jones) Heller, Muhlenb. **2**:85. 1905, quoad nom. *Astragalus inflexus* Dougl. var. *leucolobus* (Jones) Jeps., Man. Calif. 573. 1925; Munz, Man. S. Calif. 206. 1935. *Xylophacos leucolobus* (Jones) Rydb., Bull. Torr. Bot. Cl. **52**:371. 1925, pro parte; N. Amer. Fl. **24**:306. 1929.

Subacaulescent, or with several developed, prostrate, white-tomentose stems up to 3.5 cm. long, rising from the divisions of a branched caudex, forming depressed, tufted plants; herbage densely villous-tomentose with rather short, curly, more or less matted hairs; stipules imbricated or the upper shortly discrete, firmly membranous, deltoid to deltoid-acuminate, 4-10 mm. long; leaves 2.5-8 cm. long, the petioles equalling or shorter than the rachis, more or less persistent on the caudex-branches; leaflets 11-19, subcontiguous or crowded, obovate to elliptic, truncate, rounded or obscurely acute at apex, 4-12 mm. long; peduncles 3-9 cm. long, except in depauperate plants surpassing the leaves, reclinate in fruit; racemes 6-13-flowered, becoming loose, (0.5) 2-4.5 cm. long in fruit; calyx purpurascent, very shortly tomentose with crisped hairs, the cylindric tube 7-9 mm., the broadly subulate teeth 1.5-2.5 mm. long; corolla purplish, the banner 16-18 mm., the wings 15-17.5 mm., the keel 14-17 mm. long; pod lance-oblong in outline, gently arcuate almost throughout, 13-22 mm. long, 6-7.5 mm. in greatest diameter, obcompressed except in the deltoid to deltoid-acuminate, often abruptly incurved and laterally compressed beak,

strongly sulcate dorsally, the ventral suture acutish but commonly depressed and contiguous within with the impressed dorsal suture, the valves leathery, reticulate, densely but very shortly tomentose with fine, matted hairs 1 mm. long or less, inflexed (nearly always) dorsally to form a partition about 1 mm. deep, the cross-section didymous; mature seeds not seen.

Type-locality.—Bear Valley in San Bernardino Mountain, California; collected by S. B. Parish in 1892.

Distribution.—Dry open pinewoods of ranges bordering the deserts of southern California, from the San Antonio Mts. southeast to the Santa Rosa Mts.

Exsiccata.—CALIFORNIA. *Los Angeles Co.:* Swarthout Valley, Johnston No. 4614 (PO). *Riverside Co.:* Toro Peak, Munz No. 5872 (G, PO). Santa Rosa Peak, No. 15079 (G, PO), 15134 (CAS, PO). *San Bernardino Co.:* Bear Valley, Parish No. 2349 in 1892 (NY, probable isotype), No. 1813 (G, PO, fragment), No. 4966 (NY), No. 3744 (G), Ripley & Barneby in 1936. Baldwin Lake, Jones in 1927 (PO). Santa Ana River, Hall No. 7565 (PO), Munz & Johnston No. 8643 (PO).

When restricted, as Jepson was the first to do, to the montane plant of southern California with narrowly oblong, dorsally sulcate, bilocular and very shortly tomentose legume, *A. leucolobus* is a readily defined entity which can be detached from the *Purshii* complex without difficulty. At first Jepson regarded it as a variety of *A. inflexus,* which is defensible on purely morphological grounds, but this disposition of it fails to take into account the manifestly close relationships to races of *A. Purshii* which lie nearer to it geographically. Rydberg (Bull. Torr. Bot. Cl. 52:371) included in *Xylophacos leucolobus* a number of specimens from the Mt. Piños region, which in habit (except for somewhat shorter peduncles) and in the flower (with relatively short banner and long keel, or, in Jones' terminology, "stubby") do indeed resemble it, but differ in having the ovoid, inflated and long-shaggy pod of *A. Purshii* and its varieties. This puzzling form, which seems to be endemic to the South Coast Range in California, was first well described by Jones in 1895 (Proc. Calif. Acad. Sci. II, 7:669) under the name *A. leucolobus,* where it was retained in the Revision of Astragalus (although the description there would exclude it). A specimen of the same also formed an important element of the mixed *A. consectus* Sheld., and this has lately been treated by Abrams as a subspecies of *A. leucolobus* (cf. var. *longilobus,* above). While this arrangement expresses a relationship which cannot be doubted, it at the same time so weakens the characters of *A. leucolobus* sensu lato that it becomes illogical to maintain it as a species distinct from *A. Purshii.* If on the other hand the *consectus* race is referred to *A. Purshii* (of which, after all, it has the pod), *A. leucolobus* is left as a marked species. Similarly *A. leucolobus* var. *subvestitus* is best removed from the species, though in this case it seems, in spite of a close affinity, to deserve specific status. *Astragalus leucolobus,* in the restricted sense, is confined to the mountains bordering the Conchilla Desert to the north and west; records from the Panamint Mts. (Jones, 1895, l. c., Abrams, l. c., etc.) seem to be based on specimens of *A. Purshii* var. *longilobus.*

The identity of the type of *A. leucolobus,* and the proper citation of the name, need some comment. Jones originally published the latter as a manuscript binomial attributed to Sereno Watson, said to have been found on a specimen collected by S. B. Parish in Bear Valley in 1892. In an editorial footnote to the description, K. Brandegee (Zoë 4: l. c.) suggested that either Parish wrote *"leucolobus"* by mistake for *"lectulus"* (the type-locality of *A. lectulus* is also Bear Valley), or that Jones misread the annotation. At the New York Botanical Garden there is a specimen collected by Parish (his No. 2349) in 1892 bearing in his hand the determination *"A. leucolobus* Wats. ined.," which I take to be an isotype. This collection is not represented at Pomona, so that I do not know where or when Jones saw part of this collection. It seems fairly certain, in any case, that Watson neither wrote nor suggested the name, for although there are several collections of *A. leucolobus* in the Gray Herbarium which must have been there in his lifetime, none is so determined by him.

27. **Astragalus subvestitus** (Jeps.), stat. nov.

Astragalus subvestitus (Jeps.) Barneby, stat. nov. *A. leucolobus* var. *subvestitus* Jeps., Fl. Calif. **2**:361. 1936.

A. Purshii var. Jones, Rev. Astrag. Pl. 55 (fig. in lower right corner). 1923.

A. leucolobus subsp. *consectus* sensu Abrams, Ill. Fl. Pac. St. **2**:578. 1944, pro parte; non *A. consectus* Sheld.

Caulescent, the slender, presumably prostrate stems 1-8 cm. long; herbage densely silky-villous with spreading and somewhat matted hairs; stipules deltoid-acuminate, about 5 mm. long; leaves 2.5-6.5 cm. long, the slender petioles more or less persistent below; leaflets 11-13, broadly to narrowly ovate, acutish, obtuse, truncate or even emarginate at apex, 5-9 mm. long; peduncles shorter than the leaf, 1-4.5 cm. long; racemes loosely 3-8-flowered, in fruit 1.5 cm. long or less; calyx villous with short white hairs, the tube about 5 mm., the subulate teeth 2-3 mm. long; corolla purplish (?), the banner and narrow wings subequal, 10-11 mm. long, the keel 9 mm. long; pod obliquely ovoid, obtuse at base, about 15 mm. long and 5-6.5 mm. in greatest diameter, nearly straight and strongly obcompressed in the lower half, the dorsal suture there depressed-sulcate, thence abruptly arched into the deltoid-acuminate, laterally compressed beak, the ventral suture nowhere either sulcate or depressed, the valves firmly chartaceous, obscurely reticulate, yellowish-brown, rather thinly tomentose-canescent with short, tangled, subappressed hairs, not at all inflexed; seeds castaneous, dull, 1.6-2 mm. long.

Type locality.—Erskine Creek, Kern Co., California; collected by C. A. Purpus in 1897.

Distribution.—Southern Sierra Nevada in Kern (?and north to Tulare) County, California.

Exsiccata.—CALIFORNIA. *Kern Co.:* Erskine Creek, Purpus No. 5098 (G, PO, isotypes).

This apparently rare species is known to me only from the type-collection,

obtained by Purpus along a tributary of the Kern River which heads in the Piute Mountains, but Jepson also reports it, on the basis of another Purpus collection, from near the sources of the Kern in Tulare County. While imperfectly known, it differs widely from *A. leucolobus* proper not only in the much smaller calyx, corolla and legume, but also in the shape and thinner texture of the latter and in its lack of infolded partition. Jepson described the dorsal suture of the pod as "somewhat intruded," but I find it merely depressed-sulcate and not at all inflexed. From *A. Purshii* subsp. *consectus* (the var. *longilobus* of this paper), to which Abrams has reduced it, the small, thin-walled, very short-tomentose pod immediately separates it.

The type-number is, I think, 5098, not 5698 as cited in the diagnosis, but it is difficult to be quite sure whether Purpus' scrawled and open 0 may not have been intended after all for a 6. The specimen at Pomona, consisting of fragments taken from part of the type originally in the Brandegee herbarium—probably the actual type-sheet—is contained in an envelope on which Jones wrote "Drawn from this." While there is no reference to it in the text of the Revision of Astragalus, the figure is evidently that cited above as *A. Purshii* var. on Plate 55. It is fairly accurate.

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Book Reviews

INSECTS OF THE PACIFIC WORLD. By Charles Howard Curran. The Macmillan Company, New York, 1945. 317 pages, 97 figures. $3.75.

This book opens with a generalized account of insects, spiders, crustaceans and centipedes, etc., enabling the reader to recognize the difference between those groups as well as the various types of insects. Then follows a wealth of information about the important and numerous families of Diptera, the Flies, in a long and well-illustrated chapter. Still more engrossing is Chapter three, relating interesting facts about such fascinating insects as Bees, Wasps, Ants and their relatives of the order Hymenoptera. It deals with the strange nests of Stingless Bees, the cutting precision of the Megachilidae, sexual dimorphism in the large, showy Carpenter Bees (Xylocopidae) and the diverse insect hunting habits of various families of wasps. Then the reader is told how spiders are hunted by three different families, what wasps hunt Orthoptera, cicadas, cockroaches, aphids and other insects and how important pests, such as the Japanese Beetle and their relatives, are controlled by various wasp parasites; how certain wasps parasitize colonies of bees and wasps and even the puparia of the deadly Tsetse Flies. Among other interesting facts, the saltatorial propensities of certain ants here are described as well as the modes used by the tent builders of the genus *Oecophylla* in fabricating their homes of leaves.

Chapter Four is a family by family account of the beautiful members of the butterfly and moth world in the Pacific. The order Coleoptera is interestingly presented and well illustrated giving many facts about the obscure life histories of these handsome and often golden-colored insects. Chapters Six and Seven treat the True Bugs, the Hemiptera, and the Clear-Winged Bugs, the Homoptera. The generalized account of hunting Odonata is admirably written and makes fine reading.

Neuropteroid insects are briefly treated in Chapter Nine which is followed by a brief, but well-illustrated account of the Orthoptera. Chapter Eleven is devoted to some of the "small" orders, such as Fleas, Lice, Thrips, Termites and Earwigs. The author of Chapter Twelve on the Scorpions, Ticks and Mites, has given us an excellent picture of the varied habits and life histories of these interesting animals living in the Pacific World. Although volumes could be written about Insects and Disease, Chapter Thirteen acquaints the reader briefly with the more important facts about insect-borne diseases of the Pocific World. The closing chapter gives instructions on the collecting of insects and rightly emphasizes the importance of care in handling the captured specimens. It is one thing to capture an insect, but it is often a far more difficult task to take care of it in order to preserve all of its original beauty.

It is unfair to criticize a work that treats with such a huge area of the earth's surface, about which much has been written, but so little is known. However, some readers may wonder why after a fascinating introduction nothing specific is said about the handsome Dragonflies and the large, brilliant Damselflies, coruscating along the sunlit streams of the Pacific World. A few additional illustrations would have considerably enhanced the fine chapters on spiders, bees and wasps.

In summary, Dr. Curran and the other contributors have produced an excellent book in a very short time from a mass of material about one of the most fascinating areas in the world. All interested in natural history will want to see this volume on their bookshelves resting side by side with the companion volumes of the Pacific World Series. —ERNEST R. TINKHAM, Tucson, Arizona.

ANAEROBIOSIS IN INVERTEBRATES. By Theodore von Brand. Published by Biodynamica, Normandy, Missouri. 328 pp. $4.80.

This is a scholarly and valuable survey of the subject with critical references to all the available literature by an acknowledged authority and original investigator in the

field. The book is divided into three parts, dealing with, respectively, the occurrence of anaerobiosis among invertebrates, the anaerobic metabolism of invertebrates, and general adaptation to the lack of oxygen with remarks on the origin of anaerobiosis. In the first part, following a chapter on methods, it is shown that the principal natural habitats that are poor in oxygen or nearly anaerobic are the bottoms of small fresh-water bodies rich in decaying material, the lower strata of large fresh-water lakes, and the digestive tract of higher invertebrates. A survey of the available data from the different invertebrate phyla indicates that the only truly anaerobic invertebrates are the sapropelic Protozoa, chiefly ciliates, that live in the bottom mud and slime; but parasitic Protozoa, helminths, and Diptera, and certain insect larvae such as chironomids that inhabit the deep zone of lakes live satisfactorily for long periods in very low oxygen tensions. The second part, the longest and most important section of the book, deals with the actual processes of anaerobic metabolism. Many invertebrates appear able to carry on some degree of anaerobic metabolism when the oxygen tension of the medium falls below a certain level. This level varies greatly with different invertebrates without reference to taxonomic position. In some the oxygen consumption continues constant until the oxygen tension reaches a low figure whereas in others the amount of oxygen consumed is at all tensions dependent on the oxygen content of the medium. Some invertebrates in the groups of Protozoa, worms, and arthropods continue to carry on fermentative processes even in the presence of ample oxygen, in addition to aerobic oxidations, and appear to utilize energy from both sources. In anaerobic fermentations, the chief sources of energy are the carbohydrates, especially glycogen. Evidence of anaerobiosis consists in the giving off of unoxidized or incompletely oxidized end-products, especially fatty acids, lactic acid, and other organic acids, and carbon dioxide, sometimes hydrogen; and in the accumulation of an oxygen debt during a stay in anaerobic conditions. The final section presents a classification with regard to type of energy processes and discusses briefly the characteristics of the different categories in this classification. The true anaerobes, the sapropelic ciliates, are injured by oxygen at least in higher concentrations. No good reason for the toxic effect of oxygen has been advanced except the theory that hydrogen peroxide is formed in the presence of oxygen. In regard to other invertebrates, some can withstand considerable deprivation of oxygen whereas other cannot and are strictly aerobic. The former must be able to obtain energy from anaerobiosis and they must be able to dispose of toxic end products or to produce non-toxic ones. The idea that endoparasites derive from mud-dwelling anaerobic ancestors is rejected, as is also the theory that anaerobiosis preceded aerobiosis in evolution.

Altogether the book is a highly commendable aid to all those interested in the physiology of invertebrates.—L. H. HYMAN, American Museum of Natural History, New York.

THE WOLF IN NORTH AMERICAN HISTORY. By Stanley Paul Young. The Caxton Printers, Ltd., Caldwell, Idaho. 1946. 149 pages, 53 illus. $3.50.

The conflict in North America between man and the wolf is traced by Young over a period of nearly 350 years. At the earliest settlements as well as the later ones on the Atlantic Coast, the colonists suffered severe losses from depredations of wolves wherever lands were cleared and attempts made at keeping and raising livestock such as swine, sheep and cattle. Bounty inducements for wolf control were ordered as early as 1630 in the colonies. As settlers migrated farther and farther westward to clear for cultivation what were then vast wilderness tracts, wolves continued for some decades to be troublesome. The gradual disappearance of the wolf east of the Mississippi, however, is attributed in part to the progressive westward spread of our population, and the resulting destruction of its normal haunts by the cutting and burning of forests and thickets, by draining, by flooding, and by cultivating vast areas, and in part to the improvement of firearms and of the devices employed for trapping, particularly the replacement of snares, deadfalls and pits by steel traps.

On the Great Plains wolves preyed on cattle herds which were grazing on the former

buffalo, deer, elk and antelope ranges, and consequently the stockmen resorted to all available means of curtailing losses, including herders, traps, poisons, bounties and wolf-proof fences. Pioneer settlers, ranchers and stockmen on far western ranges and on the Pacific Coast had similar experiences with wolves. Owners of livestock found it expedient to organize associations to provide for the payment of wolf bounties and for the purchase of strychnine. At these "wolf meetings" local groups of stockmen were assessed for the bounty fund. Subsequently, the bounty payments were made by the counties and later by the states.

Although thousands of wolves were destroyed by wolf poisoners and trappers, there developed a general feeling that bounty payments were not producing satisfactory results. Repeated appeals from livestock interests who were paying fees to the government for the privilege of grazing cattle and sheep on the national forests resulted in federal appropriations for the purchase of wolf traps which were supplied to forest rangers and special hunters of the Forest Service. Subsequently, as the result of the pioneer studies on wolves and other predators carried on by the Biological Survey, this federal bureau was authorized under the congressional act of June 30, 1914, to conduct experiments and demonstrations in destroying wolves, prairie dogs and other animals injurious to agriculture and animal husbandry. Shortly afterward, the Forest Service field offices were instructed by the Chief Forester to transfer all trapping and other similar equipment to the Biological Survey. The following year the first federal appropriation of funds to assist in organizing predator control on national forests and other public lands was made on July 1, 1915. Increased appropriations during the ensuing fifteen years resulted in enlarged field control operations. These control operations led to the formulation of the ten-year cooperative program which was authorized by Congress in 1931.

Personal acquaintance with the problems confronting the stock raiser acquired while hunting wolves in the southwest and as an employee of the Fish and Wildlife Service, not only in the administration of predator control but also in research on all phases of the wolf's activities, make Stanley P. Young the leading authority on the wolf in North America.—REMINGTON KELLOGG, United States National Museum.

SKETCHES OF AMERICAN WILDLIFE. By Stanley Paul Young. The Monumental Press, Baltimore, Md., 1946. Pp. xii+143, 55 illus. $3.00.

In the 12 chapters comprising this book are recorded the personal observations of a naturalist who has devoted more than 25 years to a study of the early uncontrolled exploitation of our native wildlife and the ever-present conflict between human interests and the destructive propensities of predators and rodents. In addition to information acquired through a wide acquaintance among western stockmen, sportsmen and conservationists, Stan Young, formerly Chief of the Division of Predator and Rodent Control of the Fish and Wildlife Service, has incorporated in these narratives materials selected from many ancient, colonial and present-day sources.

Considerable attention has been focused of late on the coyote, which unlike most of our native mammals seems readily adaptable to changing or new conditions. Young's account of the coyote is therefore timely and interesting. Our strange wandering black-footed ferret whose life seems to have been tied rather closely with colonies of prairie dogs is depicted in the second chapter. The next account relates largely to the capture of musk oxen in Greenland, their transportation to Alaska for restocking purposes, and subsequent liberation on Nunival Island in the Bering Sea, involving a journey of some 14,000 miles. Although the pronghorn antelope was estimated to have been present in millions in the last half of the 19th century, tabulations made in 1924 indicated that there were less than 27,000 in 16 western states. Young relates the efforts that were the establishment of three refuge areas, comprising ¾ million acres, in Nevada and Oregon in the interval between 1930 and 1936. As a result of this protection and wise management, there are now some 200,000 pronghorn antelope.

Skins and furs as an article of commerce in early historical times, the wearing of certain furs as a symbol of rank among the nobility, and the subsequent demand for

many kinds of furs, which followed the discovery of fur trading opportunities in the New World and led to the organization of North American fur companies, are discussed from the historical point of view.

Surprising as it may appear to some readers, the Incas utilized and conserved wild life resources. Centuries ago these native Peruvians put into effect a game management plan for the perpetuation of the vicuna, guanaco and other game. All predators, including the puma, were killed. By pertinent citations, the author shows that for at least 2700 years, one or another kind of bounty has been offered for the killing of wolves. Control methods employed against wolves are traced from the Middle Ages in Europe and from the Colonial period to the present in the United States. Many interesting items of information are brought out in the account of the use of the oil of the catnip plant as a lure in trapping bobcats and pumas. That the scream of the puma is a fact and not fiction is shown by quoted observations of a number of naturalists. Those that have kept wild animals as pets will gain added enjoyment by reading about the daily lives of two tame prairie dogs. Bits of information, including the derivation and meaning of such once familiar terms as "greaser," "Depyler," "bit," and "buffalo chip" culled from the early records of our western states are brought together in the last chapter.

One seldom finds so much authentic natural history lore packed into one book.—REMINGTON KELLOGG, United States National Museum.

ETHNOBOTANY OF WESTERN WASHINGTON. By Erna Gunther. University of Washington Publications in Anthropology. Vol. 10, No. 1, pp. 1-62. October 1945. $1.50.

Ideally, ethnobotany is a job for taxonomic botanists, but the number of taxonomists is so small, and the amount of work in systematic botany yet remaining to be done is so large, that few taxonomists can find time or opportunity for purely ethnobotanical work. We should therefore be thankful that occasionally an anthropologist will take the trouble to try to record the rapidly dwindling data concerning the food plants of the North American Indians. Dr. Erna Gunther is one of these anthropologists. Having made many expeditions to the homes of the few remaining Indians in the Pacific Northwest for the purpose of finding out what knowledge of the plants these people had, she has now summarized the result of her investigations.

This work includes an outline map of western Washington showing the location of the various Indian tribes, a bibliography of 22 titles, a tabular list of the plants discussed in the text, and an index to English and scientific names. Forty-three pages are devoted to explanations of the plants and their uses. The material is arranged in botanical order under the plant families, which follow the well-known Engler & Prantl sequence. A total of more than 150 species is treated, including 10 ferns, and 9 gymnosperms. A few thallophytes are mentioned at the end of the treatment of the flowering plants. There are listed for each species the accepted binomial, an English name, as well as the name or names used by Indian tribes, in phonetic transcription. The plants used by the Indians are dealt with concisely, according to their uses, whether for medicine, food or other purposes. It is interesting to note that the Indian informants were competent to distinguish between native and adventive species, and were usually able to furnish no information about such recently adventive plants as *Geranium molle*, *Verbascum thapsus*, *Digitalis purpurea*, and *Arctium minus*, which, although common enough at the present time, evidently had no known ethnobotanical significance. An occasional botanical lapsus is to be found here and there in the text, as in a footnote on page 13, where *Glycyrrhiza lepidota*, a leguminous plant, is often confused with a fern, *Polypodium vulgare*, probably on the basis of D. C. Eaton's *P. glycyrrhiza*.

Such minor errors are of course of little importance, and will not detract from the general usefulness of the work to anthropologists and botanists alike, especially in view of the fact that a key set of specimens of the plant discussed is available for reference at the Washington State Museum in Seattle.—GEORGE NEVILLE JONES, University of Illinois.